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DE LENERGIE DANS LES BATIMENTS

Survey of Energy Performance of Warehouses

A RESEARCH REPORT

Canada

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Survey of Energy Performance of Warehouses

A RESEARCH REPORT

A Survey of 19 Warehouses and 20
Light Industrial Buildings

Sponsored by the
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Energy, Mines and Resources Canada

Prepared by
Building Engineering Group
Waterloo, Ontario

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The Buildings Energy Technology Transfer (BETT) Program of Energy, Mines and Resources Canada has been created to assist building owners, users, and practitioners active in the design, construction, and operation of buildings in identifying technical obstacles to energy conservation. Through a nationwide network of research agencies and private sector consultants, BETT carries out research and development projects and provides the audiences mentioned above with technical reports, how-to manuals, training manuals, audio-visual aids and data bases.

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ABSTRACT

In November 1981, a survey to assess and document the energy-related performance of representative warehouse and light industrial buildings was initiated. A total of 39 buildings, 19 warehouses and 20 light industrial buildings were surveyed. All the buildings are in southwestern Ontario and, in terms of size, age and use, the sample is fairly representative of these building subcategories.

In addition to a physical survey of each building, a computerized energy analysis procedure, BEGEN, was developed. The BEGEN program is essentially an extension of the HOTCAN program for application to warehouse and light industrial buildings. A database, dbBEG, has been developed to store and permit retrieval of the data collected.

This report presents a summary of the data collected for both warehouses and light industrial buildings. Where possible, the BEGEN program has been run to simulate energy use in each building. Building characteristics are summarized under six categories as follows:

- Overall Survey Data
- Annual Energy Consumption
- Summary of Energy End-Use
- Energy Balance
- Construction Details
- Operating Details

ABSTRACT (Continued)

Short descriptions of each building are included in Appendix A. In addition, a sample printout of the information for one building collected has been included. Information for 22 of 39 buildings is stored on the dbBEG database, and this can be accessed by contacting the Building Engineering Group at the University of Waterloo's Civil Engineering Department, Waterloo, Ontario.

RÉSUMÉ

En novembre 1981, on a entrepris de faire l'évaluation du rendement énergétique d'entrepôts et de bâtiments de l'industrie légère constituant un échantillon représentatif de ces immeubles. On a étudié 39 immeubles, soit 19 entrepôts et 20 bâtiments de l'industrie légère, se trouvant dans le sud-ouest de l'Ontario et représentant assez bien les immeubles de ces sous-catégories par leurs dimensions, leur âge et leur emploi. On a ensuite compilé les données relevées.

On a en outre mis au point un programme informatisé d'analyse du rendement énergétique, dit BEGEN, qui est essentiellement un prolongement du programme HOTCAN et s'applique expressément aux entrepôts et aux bâtiments de l'industrie légère. Enfin, on a constitué la base de données dbBEG, où l'on a stocké les données recueillies aux fins de consultation ultérieure.

Le lecteur trouvera aux pages qui suivent un résumé des données recueillies au sujet des entrepôts et des bâtiments de l'industrie légère. Le programme BEGEN a été appliqué à tous les cas qui s'y prêtaient, afin de simuler l'emploi d'énergie des immeubles, et les données compilées pour chacun ont été réparties sous six rubriques :

- Généralités
- Consommation annuelle d'énergie
- Résumé des emplois finals d'énergie
- Équilibre énergétique
- Particularités de construction
- Particularités d'exploitation

Le présent rapport renferme également, en annexe, une brève description de chaque immeuble inspecté, ainsi qu'un échantillon de l'imprimé produit pour un immeuble précis. Les données se rapportant à 22 des 39 immeubles étudiés ont été versées dans la base dbBEG et sont disponibles par l'intermédiaire du Building Engineering Group.

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FOREWORD

Over a two-year period spanning 1981, 1982 and 1983, the Building Engineering Group conducted surveys of thirty-nine different warehouses and light industrial buildings in southern Ontario. The energy-related scope of this survey was prescribed to conform to the data input needs of the HOTCAN energy analysis program (or a modified version thereof, namely BEGEN). The survey was not intended as an "end-use" survey and care must be exercised in the use of the information. The following hierarchy of data reliability needs to be appreciated:

- primary data - recorded or measured, relatively accurate and trustworthy information (building plans, fuel bills, etc.)

- secondary data - derived or estimated directly from primary data with the minimum of simplification and manipulation (transmission losses, fuel usage in terms of energy, etc.)

- tertiary data - derived or estimated from a mix of primary and secondary data (estimates of process and other heat gains, the natural infiltration rate, seasonal conversion efficiencies, etc.)

The document that follows is largely a vehicle to record some of the data accumulated by BEG during the course of the survey. The information should be used with caution and, preferably, not taken out of context.

E.F.P. Burnett
Building Engineering Group
March 1985

The Buildings Energy Technology Transfer (BETT) Program was initiated by the Department of Energy, Mines and Resoures (EMR) in late 1981. The principal objectives of this program are to:

- develop and deliver necessary technical information and know-how to practitioners in the field
- hasten the development and use of proven energy conservation technologies
- support EMR's energy conservation policies and programs through research and expert advice.

The Building Engineering Group (BEG) was selected by EMR to develop and execute a comprehensive R, D and D program for energy conservation in the warehouse and light industrial building sector. The warehouse and light industrial building sector is particularly important because:

- the building stock involved is extensive--well over one billion square feet
- until 1981, very little R and D, energy-related or otherwise, had been directed towards buildings of this general type.

The lack of documented information has been a significant problem in dealing with warehouse and light industrial buildings (WLIBs). A review of the state-of-practice would provide information on which a well-directed energy conservation technology transfer program could be based.

Of the total area of WLIBs in Canada, warehouse buildings comprise 61% and light industrial buildings the remaining 39%.

The overall objective of the Survey Task was to develop a comprehensive, documented base of information concerning the nature of WLIBs and their performance--especially their energy-related performance--by means of a detailed examination of an appropriate sample of existing buildings.

Energy performance data were required to assess the relative importance of various causes of gross energy consumption in the buildings, e.g., infiltration losses, electrical usage, etc. and to identify potential areas for savings.

The object of this report is to summarize and document the data that has been collected. The report provides a quantitative description of the stock of WLIBs, their construction and operation and annual energy costs. This information can be used by building owners, developers, architects and engineers as a comparative datum for evaluating the performance of existing buildings and designing new buildings.

3. SCOPE

The survey was limited to 19 warehouses and 20 light industrial buildings (LIBs) situated in southern Ontario.

The scope and scale of the energy audit was to be consistent with the capabilities of the HOTCAN program developed by the National Research Council for the housing industry. Considerable developmental work was required to adapt the program to handle WLIBs. The modified energy analysis program, called BEGEN, was developed for the IBM PC or compatible equipment.

4.1 PRELIMINARY INVESTIGATION

An effort was made to gather other audit or survey data on energy performance of the WLIB sector. Contact was made with the provincial authorities in Nova Scotia, Ontario, Manitoba and British Columbia conducting the Energy Bus program. Very few WLIBs had been included in their surveys, and there were potential problems with the confidentiality of the information.

4.2 SURVEY

The survey was carried out in three stages:

(i) the preliminary stage when a building is identified and arrangements to do the survey have to be made

(ii) the site survey

(iii) a follow-up stage involving data compilation and analysis, reporting and dealing with any feedback.

The funding limit dictated that each building be visited only once, that each visit be limited to a day, and that measurement be kept to a minimum. No monitoring was conducted. Given these constraints, the survey was more than a "walk-through" audit but somewhat less than a full-scale investigative survey. The survey was not an energy "end-use" study.

The survey was limited to a small sample (19 warehouses and 20 LIBs) and all the buildings are in southwestern Ontario. The survey sample is not necessarily representative of WLIBs in other geographic or climatic regions.

Often neither owner nor tenant had a satisfactory record of fuel consumption and its cost. However, with permission, these data could usually be obtained from the relevant utility. A more difficult problem was the lack of operating schedules. Only rarely was an owner able to supply door-operating schedules, for example. Some knowledge of the movement of goods, i.e., traffic scheduling, and the related proportion of goods stored and the mean temperature would have been of considerable value, but we were unable to find a warehouse with this kind of record-keeping.

This level of survey and data analysis was not appropriate for buildings with large process energy requirements. Moreover, the amount of energy used for functions such as outdoor lighting, domestic hot water, the charging of batteries, and block heating was neither available nor measured.

A problem of scale is encountered with very large buildings. For example, when a multi-structure facility has a total of 141,410 m^2 under one roof, then certain assumptions regarding the time-averaged internal mean temperature are likely to be invalid.

Another problem was firstly establishing and secondly confirming the thermal resistance of the roof.

4.3 PREPARATION OF THE DATABASE

A computer database was created to facilitate storage and retrieval of data gathered in the course of the survey. This database, called dbBEG, can be operated in on an IBM PC computer or compatible equipment. Only twenty-two of the buildings were suitable for or worth recording in the database.

An example of the dbBEG printout of survey data for one building is included in Appendix B.

4.4 DEVELOPMENT OF THE ENERGY ANALYSIS SOFTWARE

One of the objectives of this survey was to perform an "audit" level analysis of the buildings. HOTCAN was developed for residential buildings and had to be modified for WLIBs.

One of the important limitations of the BEGEN analysis is that it does not calculate the infiltration losses directly. It computes losses through walls, doors, windows, roofs and floors and assumes that the balance of energy is lost through infiltration. An iterative procedure is then used to compute the corresponding air change rate.

5. COMPILATION OF THE DATA

5.1 SUMMARY DATA

The following tables and figures present the summarized building data:

Table 1: Overall Survey Data
Table 2: Annual Energy Consumption
Table 3: Summary of Energy End-Use
Table 4: Energy Balance
Table 5: Construction Details
Table 6: Operating Details

Figure 1: Energy Cost Breakdown and
Heat Loss Breakdown:
Average Warehouse

Figure 2: Energy Cost Breakdown and
Heat loss Breakdown:
Average Light Industrial Building

Except for Table 1, the building data has been summarized by type of building in order of decreasing floor area. The first column of each summary table contains the building number, which can be used to cross-reference the other summary tables and the individual building descriptions in Appendix A.

TABLE 1: OVERALL SURVEY DATA

BUILDING NUMBER	BUILDING TYPE	NATURE OF TENANCY	LOCATION	YEAR BUILT	INTERNAL FLOOR AREA (m^2)	VOLUME TO AREA RATIO = MEAN HEIGHT (m)	% OFFICE AREA	PROCESS HEAT	COMMENTS
1	W	O	WATERLOO	69	2838	4.96	1	N	
2	W	O	LONDON	75	23280	8.00	13	N	
3	LIB	R	WATERLOO	58	323	4.03	15	N	
4	W	O	KITCHENER	67	928	6.92	0	N	
5	LIB	O	KITCHENER	69	858	4.19		H	HEAT RECOVERY
6	W	O	KITCHENER	65	1162	4.57	10	N	
7	LIB	O	WATERLOO	81	1909	5.36	12	L	
8	LIB	O	WATERLOO	77	546	6.48	24	M	
9	LIB	O	WATERLOO	79	718	4.74	5	H	SOME COLD STORAGE
10	W	O	WATERLOO	72	1237	5.28	15	L	
11	W	R	KITCHENER	72	2280	6.00	3	N	UNHEATED
12	W	R	KITCHENER	72	11176	8.47	3	N	
13	W	O	KITCHENER	67	937	5.10	5	N	
14	LIB	R	WATERLOO	68	4550	5.20	10	N	MULTI TENANT
15	W	O	TORONTO	68	3241	5.15	20	N	
16	LIB	O	WATERLOO	82	724	5.08	7	L	
17	W	O	TORONTO	75	38854	9.65	6	L	
18	W	R	TORONTO	68	38558	8.23	2	L	NO ELECTRICAL DATA
19	LIB	O	KITCHENER	78	4721	5.38	24	H	NO FUEL DATA
20	LIB	O	KITCHENER	64	525	3.20	2	L	NO FUEL DATA; PROCESS HEAT
21	W	R	KITCHENER	63	2201	5.03	33	L	INADEQUATE FUEL RECORDS
22	W	R	KITCHENER	63	2148	7.00	3	N	UNHEATED
23	LIB	O	KITCHENER	77	2348	5.33	11	H	HEAT RECOVERY
24	W	O	MARKHAM	83	6873	5.45	25	L	NO FUEL DATA
25	LIB	O	TORONTO	54	13514	6.20	32	H	
26	LIB	O	GUELPH	75	632	5.70	12	H	NO ELECTRICAL DATA
27	LIB	O	KITCHENER	56	1636	4.15	11	H	OIL HEAT
28	LIB	O	GUELPH	70	1569	4.43	4	M	PROCESS HEAT
29	LIB	O	WATERLOO	73	373	4.41	25	M	
30	LIB	R	WATERLOO	68	2148	4.67	16	H	
31	LIB	O	WATERLOO	70	2021	5.26	11	L	
32	W	O	BRAMPTON	73	133238	18.14	3	L	
33	LIB	O	GUELPH	76	3473	7.18	19	N	
34	LIB	R	WATERLOO	64	2197	5.50	2	N	
35	W	R	KITCHENER	64	5290	5.00	1	N	
36	W	O	TORONTO	74	19148	7.78	5	N	
37	W	O	TORONTO	73	18427	8.38	8	N	
38	W	O	TORONTO	60	18305	8.38	0	N	
39	LIB	O	MARKHAM	64	65000	6.00	3	H	POOR FUEL DATA

LEGEND:

O = OWNED
R = LEASED

H = HEATED
U = UNHEATED

W = WAREHOUSE
LIB = LIGHT INDUSTRIAL BUILDING

H = A HIGH LEVEL OF PROCESS HEAT
M = A MEDIUM LEVEL OF PROCESS HEAT
L = A LOW LEVEL OF PROCESS HEAT
N = NEGLIGIBLE PROCESS HEAT

Table 2. Annual Energy Consumption

Bldg. No.	Floor Area (m2)	Fuel Year	Natural gas			Electricity				Total		
			Energy Cons. (GJ)	Cost $	Index (GJ/m2)	Energy Cons. (GJ)	Cost $	Index		Energy Cons. (GJ)	Cost $	Index (GJ/m2)
								(GJ/m2)	(kWh/m2)			
32	133238	82	75842	298455	0.57	56105	533468	0.42	116.97	131947	831923	0.99
17	38854	82	44411	123567	1.14	11240	99588	0.29	80.36	55651	223155	1.43
2	23280	80/81	26840	83246	1.15	5418	45898	0.23	64.65	32258	129144	1.39
36	19148	81/82	11110	42578	0.58	2887	29101	0.15	41.88	13997	71679	0.73
37	18427	82	13458	58171	0.73	2484	25324	0.13	37.45	15942	83495	0.87
38	18305	82	7388	35252	0.40	1398	11208	0.08	21.21	8786	46460	0.48
12	11176	82	10629	39901	0.95	1626	18924	0.15	40.41	12255	58825	1.10
35	5290	82	6095	27168	1.15	439	5022	0.08	23.05	6534	32190	1.24
15	3241	81	3298	11581	1.02	1246	12634	0.38	106.79	4544	24215	1.40
1	2838	81/82	2859	11281	1.01	625	6191	0.22	61.17	3484	17472	1.23
10	1237	82	1256	5482	1.02	310	3132	0.25	69.61	1566	8614	1.27
6	1162	81/82	1813	8046	1.56	185	2003	0.16	44.22	1998	10049	1.72
13	937	82	896	4295	0.96	112	1365	0.12	33.20	1008	5660	1.08
4	928	81/82	1208	5414	1.30	70	704	0.08	20.95	1278	6118	1.38

Table 3. Summary of Energy End-Use

Bldg. No.	Floor Area (m2)	Electricity						Heating Fuel							Calc HHV (GJ)	HHV + Gains (GJ)
		Int. Lighting %	Ext. Lighting %	Air-Cond. %	Other		Total (GJ/a)	Infil. Loss %	Wall Loss %	Dr. Win. Loss %	Roof Loss %	Floor Loss %	Fuel Con Loss %	Other Loss %		
					Int. %	Ext. %										
32	133238	*	*	*	*	*	56105	59.1	12.6	4.0	16.2	1.5	6.5	*	75831	116630
17	38854	*	*	*	*	*	11240	44.9	11.4	2.2	15.2	1.1	25.3	*	44441	52794
2	23280	*	*	*	*	*	5418	34.0	7.3	2.0	29.6	0.9	26.2	*	26857	30702
36	19148	*	*	*	*	*	2887	10.1	23.5	2.4	41.6	1.0	21.4	*	11109	12953
37	18427	*	*	*	*	*	2484	31.6	9.4	5.1	25.7	2.3	25.8	*	13450	15650
38	18305	*	*	*	*	*	1398	16.1	14.2	7.5	35.8	0.9	25.6	*	7386	8660
12	11176	*	*	*	*	*	1626	38.8	6.9	0.4	26.1	0.4	27.5	*	10621	11596
35	5290	*	*	*	*	*	439	25.6	16.8	5.4	21.1	2.9	28.2	*	6091	6481
15	3241	*	*	*	*	*	1246	35.6	11.6	5.2	22.0	1.9	23.8	*	3301	4163
1	2838	*	*	*	*	*	625	32.0	16.6	4.6	19.6	0.9	26.2	*	2860	3272
10	1237	*	*	*	*	*	310	21.2	26.1	2.7	22.2	1.8	26.1	*	1256	1446
6	1162	*	*	*	*	*	185	27.7	14.5	9.0	21.3	1.3	26.2	*	1813	2076
13	937	*	*	*	*	*	112	26.2	18.4	5.1	18.5	5.1	26.6	*	896	1010
4	928	*	*	*	*	*	70	34.2	35.5	1.8	17.0	1.9	9.7	*	1209	1249

Table 4. Energy Balance

Bldg. No.	ENERGY IN								Air Changes Per Hour	ENERGY OUT						
	Heating Value (HHV) Actual	Heating Value (HHV) Calc.	Internal Gains				Net Solar Gain	Total Energy In		Infil. Loss	Wall Loss	Doors & Windows Loss	Roof Loss	Floor Loss	Fuel Conv. Loss	Total Out
			Lighting Gain	Other Electric Gain	People Gain	Total Internal Gains										
32	75842	75831	*	*	*	39025	1774	116630	0.26	68878	14748	4712	18931	1778	7583	116630
17	44411	44441	*	*	*	7572	782	52794	0.65	23688	6022	1165	8001	587	13332	52794
2	26840	26857	*	*	*	3714	132	30702	0.54	10427	2236	604	9099	279	8057	30702
36	11110	11109	*	*	*	1732	112	12953	0.10	1310	3038	314	5390	124	2777	12953
37	13458	13450	*	*	*	1821	379	15650	0.32	4953	1477	804	4027	356	4035	15650
38	7388	7386	*	*	*	827	447	8660	0.12	1391	1228	650	3096	79	2216	8660
12	10629	10621	*	*	*	945	30	11596	0.67	4501	803	42	3022	41	3186	11596
35	6095	6091	*	*	*	308	81	6481	0.55	1658	1090	351	1369	186	1827	6481
15	3298	3301	*	*	*	801	61	4163	0.99	1482	482	215	914	79	990	4163
1	2859	2860	*	*	*	379	33	3272	1.14	1047	544	151	642	30	858	3272
10	1256	1256	*	*	*	185	4	1446	0.57	306	377	39	320	27	377	1446
6	1813	1813	*	*	*	118	144	2076	1.43	575	300	187	442	28	544	2076
13	896	896	*	*	*	74	40	1010	0.46	265	186	51	187	51	269	1010
4	1208	1209	*	*	*	40	0	1249	0.90	427	444	23	212	23	121	1249

TABLE 5. CONSTRUCTION DETAILS

Bldg. No.	Year Built	Volume M^3	Floor Area M^2	Floor Thermal RSI	Wall Area M^2	Wall Thermal RSI	Roof Area M^2	Roof Thermal RSI	Shipping Doors No.	Shipping Doors Area M^2	Shipping Doors Thermal RSI	Man Doors No.	Man Doors Area M^2	Man Doors Thermal RSI	Windows Area M^2	Windows Thermal RSI
WAREHOUSES																
32	1973	2,416,667	133,238	0.2	48,458	1.08	133,238	2.32	*	3119	0.35	*	64	0.20	1875	0.37
17	1975	374,941	38,854	0.2	7271	0.35	38,854	1.41	22	264.3	0.43	11	23.7	0.40	663.4	0.20
2	1975	186,240	23,280	0.2	4122	0.58	23,280	0.80	*	631	0.47	*	76.4	0.30	90.6	0.33
36	1974	148,933	19,148	0.2	4584	0.48	19,148	0.95	26	189.3	0.35	8	20.7	0.40	120.1	0.20
37	1973	154,489	18,427	0.2	5269	1.08	18,427	1.39	16	184.1	1.33	11	23.9	2.50	475.5	0.23
38	1960	153,471	18,305	0.2	5538	1.06	18,305	1.39	18	191.4	0.47	13	21.9	0.36	454.3	0.20
12	1972	94,705	11,176	0.2	3795	1.01	11,176	0.79	5	31.0	0.50	7	13.0	1.30	31.8	0.26
35	1964	26,540	5,290	0.2	1287	0.40	5,290	1.31	12	136.6	0.35	8	15.3	0.40	121.6	0.20
15	1968	16,688	3,241	0.2	1068	0.60	3,241	0.96	*	30.0	0.26	*	15.0	0.35	151.2	0.27
1	1969	13,912	2,838	0.2	957	0.35	2838	0.88	8	125.3	0.35	10	27.9	0.40	32.0	0.20
10	1972	6,537	1,237	0.2	718	0.47	1,237	0.96	3	44.0	0.48	6	12.0	0.40	12.5	0.37
6	1965	5,315	1,162	0.2	462	0.35	1,162	0.60	3	30.5	0.35	7	14.5	0.40	154.0	0.22
13	1967	4,776	937	0.3	621	1.20	937	1.80	2	17.3	0.40	5	9.2	0.32	30.0	0.44
4	1967	6,259	928	0.2	778	0.40	928	1.00	4	51.9	0.51	3	5.9	0.40	0.0	---
LIGHT INDUSTRIAL BUILDINGS																
25	1954	83,814	13,514	0.2	1,778	1.24	13,514	1.01	*	7.5	0.40	*	15.1	0.43	420.2	0.43
14	1968	23,660	4,550	0.2	1,479	0.65	4,550	0.90	*	67.0	0.20	*	43.0	0.30	75.2	0.30
33	197	24,944	3,473	0.27	1,943	1.71	3,473	1.78	*	11.5	0.40	*	36.5	0.40	107.2	0.37
23	1977	12,057	2,347	0.2	971	1.24	2,347	1.28	*	8.4	0.40	*	13.4	1.25	84.5	0.33
34	1964	12,081	2,197	0.2	849	0.40	2,197	1.36	5	50.0	0.35	8	13.5	0.40	111.2	0.20
30	1968	10,041	2,148	0.2	964	0.41	2,148	1.35	1	11.4	0.35	7	13.0	0.40	35.4	0.38
31	1970	10,623	2,021	0.2	1,068	0.44	2021	1.31	5	83.2	0.35	9	14.1	0.40	33.8	0.31
7	1981	10,222	1,909	0.2	983	2.58	1,909	3.63	2	14.9	1.25	7	15.2	1.09	35.5	0.38
27	1956	6,783	1,636	0.2	568	0.57	1,636	1.05	*	39.8	0.35	*	7.8	0.53	121.9	0.22
28	1970	6,953	1,569	0.2	721	1.08	1,569	1.35	3	28.2	0.35	6	15.13	0.41	28.4	0.24
5	1969	3,595	858	0.2	465	0.76	858	0.86	2	16.2	0.35	7	13.65	0.35	33.6	0.40
16	1982	3,678	724	0.2	464	1.14	724	2.50	3	40.1	0.42	4	5.9	1.26	30.9	0.44
9	1979	2,528	553	0.2	417	0.54	553	0.96	1	9.3	0.43	2	3.9	0.40	5.0	0.22
8	1977	3,539	553	0.2	483	1.66	547	2.14	2	21.6	0.44	4	7.4	0.40	12.8	0.38
29	1973	1,646	373	0.2	321	1.03	373	1.07	*	6.6	0.40	*	1.9	0.35	18.0	0.26
3	1958	1,301	280	0.2	288	0.46	280	0.42	2	11.7	0.44	2	3.9	0.44	8.5	0.20

* information not available

TABLE 6. OPERATING DETAILS

	Main Area					Office				Shipping Doors
	Operating		Setback		% Office Space	Operating		Setback		
Building No.	Temp. °C	% Time	Temp. °C	% Time(c)		Temp. °C	% Time	Temp. °C	% Time(c)	% Time Open
WAREHOUSES										
32	*	*	*	*	<3	*	*	*	*	47.6
17	18	23.8	18	76.2	6	20	23.8	20	76.2	5.0
2	*	*	*	*	13	*	*	*	*	*
36	16	71.4	10	28.6	4.5	21	71.4	10	28.6	11.2
37	14	23.8	6	47.6	8.0	14	23.8	6	47.6	10.0
38	15	23.8	6	76.2	0	N/A	N/A	N/A	N/A	7.5
12	20	26.2	10	73.8	2.7	21	23.8	21	76.2	0.4
35	18	29.8	18	70.2	<1	22	29.8	22	70.2	6.6
15	*	*	*	*	*	20	*	*	*	*
1	18	23.8	14	76.2	14	20	23.8	18	76.2	3.3
10	13	23.8	13	76.2	15	20	23.8	20	76.2	2.1
6	18	23.8	13	76.2	10	18	23.8	13	76.2	16.7
13	20	23.8	20	76.2	5	21	23.8	16	76.2	12.5
4	45	23.8	45	76.2	0	N/A	N/A	N/A	N/A	0.6
LIGHT INDUSTRIAL BUILDINGS										
25	*	*	*	*	32	*	*	*	*	*
14	*	*	*	*	<10	*	*	*	*	*
33	*	*	*	*	19.1	*	*	*	*	*
23	*	*	*	*	11.4	*	*	*	*	*
34	19	23.8	19	76.2	1.8	19	23.8	19	76.2	3.5
30	20	23.8	20	76.2	18.4	20	23.8	20	76.2	0.0
31	20	23.8	14	76.2	13.5	20	23.8	14	76.2	4.2
7	18	35.7	10	64.3	12.6	24	32.7	10	67.3	8.3
27	*	*	*	*	11.4	*	*	*	*	*
28	17	23.8	17	76.2	3.8	19	23.8	19	76.2	4.4
5	21	23.8	18	76.2 (a)	2.9	*	*	*	*	0.2
16	15	23.8	10	76.2	15	21	23.8	10	76.2	1.0
9	2	23.8	2	76.2 (b)	4.5	16	23.8	10	76.2	6.3
8	18	23.8	18	76.2	22.6	20	23.8	10	76.2	8.3
29	*	*	*	*	24.9	*	*	*	*	*
3	19	23.8	10	76.2	15	22	23.8	22	76.2	2.1

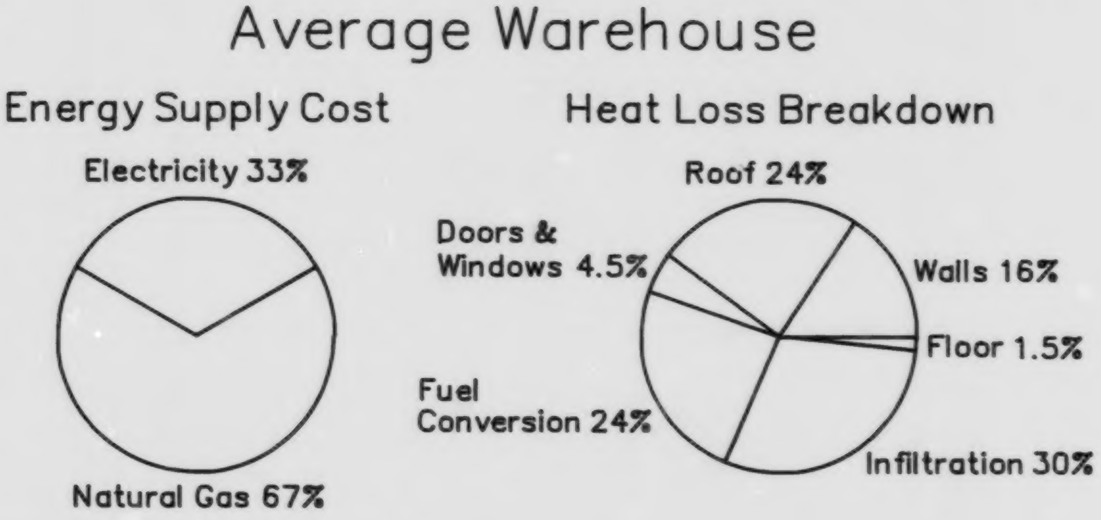
* Information not available.

(a) One of the three areas having three different systems with three separate setpoints.

(b) Chilled rooms--waste heat used to heat main area.

(c) Percent of time for temperature setbacks does not necessarily include all of setbacks in a given week.

FIGURE 1

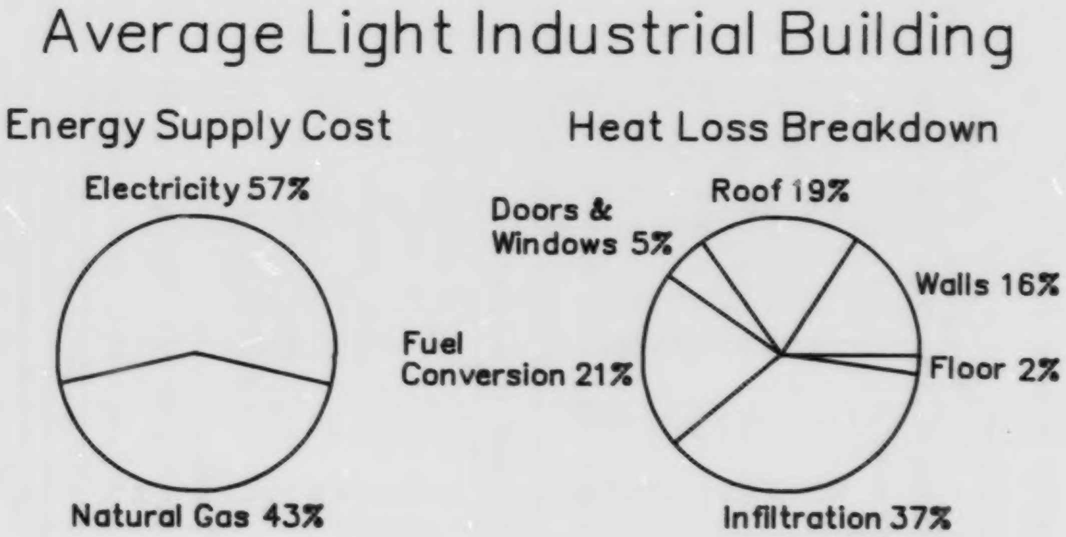


Average Warehouse

Energy Supply Cost

Heat Loss Breakdown

FIGURE 2



Average Light Industrial Building

Energy Supply Cost

Heat Loss Breakdown

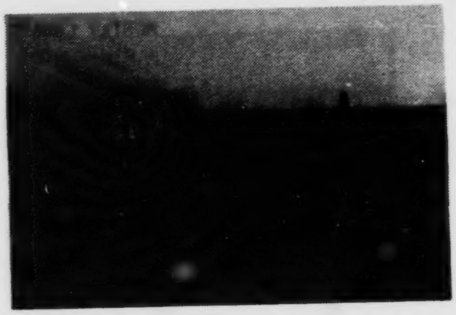
APPENDIX A

INDIVIDUAL BUILDING DESCRIPTIONS

The building descriptions are ordered sequentially by building number. Each description contains a photograph of the building, a summary of the location, occupancy, structure, service systems, and an analysis of energy use, including a pie-chart showing the breakdown of energy use and heat loss. Comments summarize and interpret the survey data and the results of the energy analysis. Possible problem areas and some improvement opportunities are identified.

Photographs are not available for every building. BEGEN output is provided for most buildings but this data must be interpreted with caution. In a number of instances data is inaccurate, unavailable or unreliable and BEGEN output has not been provided.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY



FILE NUMBER : 20601-01

BUILDING TYPE : WAREHOUSE

BUILDING NAME : BAUER WAREHOUSE

BUILDING ADDRESS : NORTH CAMPUS, UNIVERSITY OF WATERLOO

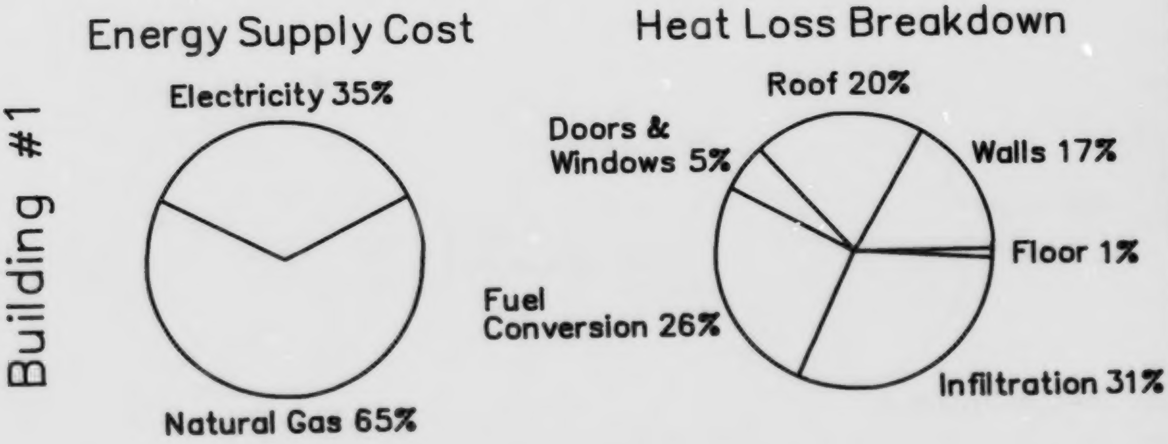
LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE STRUCTURE WAS DISMANTLED AND REBUILT ON THE CURRENT SITE IN 1969. THE BUILDING IS OWNED BY THE UNIVERSITY OF WATERLOO AND USED AS FOLLOWS: 65% OF THE BUILDING IS STORAGE AND MAINTENANCE AREAS FOR THE ROADS AND GROUNDS DEPARTMENT OF THE UNIVERSITY, 25% IS STORAGE FOR INFREQUENTLY USED UNIVERSITY MATERIAL, 10% IS A STUDENT OPERATED RADIO STATION. THE EARTH SCIENCES DEPARTMENT OPERATES A SMALL UNHEATED SHED ATTACHED TO THE SOUTH SIDE OF THE BUILDING.

STRUCTURE : EXTERIOR CONCRETE BLOCK WALLS SUPPORT THE ROOF STEEL JOISTS, THE INTERIOR SUPPORTS ARE STEEL BEAMS ON STEEL COLUMNS. THE BUILDING IS A ONE STOREY STRUCTURE WITH A TOTAL FLOOR AREA OF 2606 m^2. THE WALLS ARE 4.9m TO THE UNDERSIDE OF THE ROOF DECK. THERE ARE EIGHT LARGE SHIPPING DOORS, EIGHT MAN DOORS, 32 m^2 TOTAL WINDOWS, 20% OF WHICH FACE SOUTH. THE ROOF IS INSULATED.

SYSTEMS : GAS FIRED UNIT HEATERS PROVIDE SPACE HEAT FOR THE GROUNDS DEPARTMENT AND STORAGE AREAS. THE UNIT HEATERS ARE AUTOMATICALLY SETBACK TO 10° C AT NIGHT. GAS FIRED FORCED AIR FURNACES HEAT THE OFFICE AREAS. THE RADIO STATION ALSO HAS CENTRAL AIR COOLING/DEHUMIDIFICATION. THE WASHROOMS, AND THE GARBAGE TRUCK ROOM HAVE MECHANICAL EXHAUSTS. INTERIOR LIGHTING IS FLUORESCENT, EXTERIOR IS EITHER INCANDESCENT OR HIGH INTENSITY DISCHARGE. THE HOT WATER IS PROVIDED BY ONE GAS FIRED TANK.

ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING AND HOT WATER. ELECTRICITY PROVIDES LIGHTING, COOLING, AND VENTILATION. THE 1981-82 HEATING CONSUMPTION WAS 2859 GJ; $11,281; 1.01 GJ/$m^2$ YEAR; 0.21 GJ/m^3 YEAR. THE ELECTRICAL CONSUMPTION WAS 625 GJ; $6,191, 0.22 GJ/$m^2$.



COMMENTS : THE LARGEST CONTRIBUTOR TO THE HEATING LOAD IS AIR INFILTRATION (43%), MOSTLY CAUSED BY SHIPPING DOORS AND THEIR OPERATION. THE DOORS ARE OPENED A MINIMUM OF EIGHT TIMES A DAY TO BRING VEHICLES INTO THE BUILDING, THUS EVACUATING THE WARM AIR AND INTRODUCING COLD VEHICLES. BUILDING CRACKS AT DOORS AND WINDOWS ARE LESS IMPORTANT AS ARE OTHER HIDDEN SOURCES OF AIR LEAKAGE, SUCH AS THE EXHAUST FANS, AND THE FIVE DRAINAGE TRENCHES. THE INFILTRATION RATE IS ESTIMATED TO BE 1.14 AIR CHANGES PER HOUR. THE TWO FORCED AIR FURNACES FOR THE OFFICES AND THE RADIO STATION HAVE FRESH AIR INTAKES. THE DAMPERS IN BOTH DUCTS WERE OPEN WHEN THE BUILDING WAS SURVEYED. MOREOVER, THE PLENUM ABOVE THE CEILINGS IS USED AS A RETURN AIR SHAFT (DEPRESSURIZED), WHICH INCREASES AIR INFILTRATION AT THE ROOF/WALL JUNCTION. THIS JUNCTION IS NOT WELL SEALED, AND IN SEVERAL LOCATIONS DAYLIGHT IS VISIBLE.

THE ROOF (27%) AND WALLS (29%) ACCOUNT FOR THE BULK OF THE REMAINING HEAT LOSS, DUE TO THE LARGE SURFACE AREAS AND MINIMAL INSULATION.

THE SALT DEPOSITS (EFFLORESCENCE) ON THE INTERIOR SURFACE OF THE SOUTH AND EAST WALLS INDICATE THAT INFILTRATION IS PREVALENT ON THOSE WALLS.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-02

BUILDING TYPE : WAREHOUSE WITH OFFICE AREA

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : LONDON AREA, ONTARIO

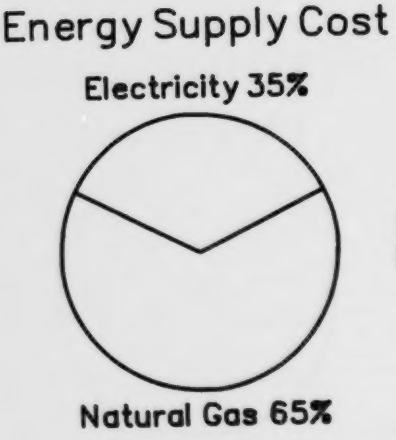
OCCUPANCY : THE DISTRIBUTION CENTRE/WAREHOUSE RECEIVES AND SHIPS EQUIPMENT WORLDWIDE. THE NORTH AREA IS DEVOTED TO PACKING PARTS IN CRATES. THE BUILDING IS OWNED BY THE OCCUPANT, PEAK OCCUPANCY INVOLVES 75 PEOPLE.

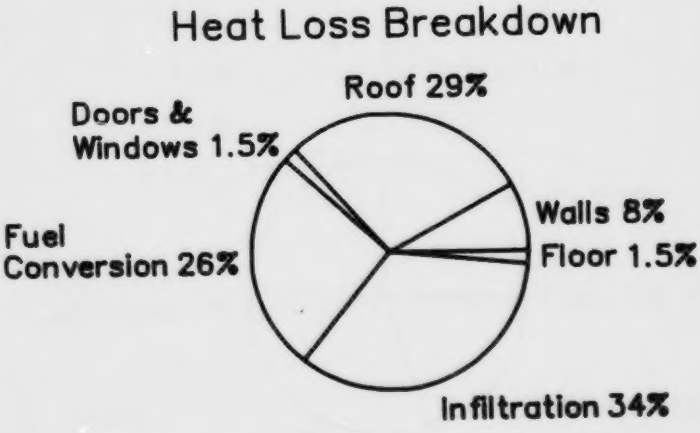
STRUCTURE : THIS IS A LARGE, ONE STOREY 23,280 m^2 FLOOR AREA WAREHOUSE, OF WHICH 3,200 m^2 (13%) IS OFFICES. THE METAL ROOF DECK IS SUPPORTED ON STEEL BEAMS AND COLUMNS. IT IS 8.0m ABOVE THE FLOOR SLAB. THE ROOF IS ESSENTIALLY UNINSULATED. THERE IS ONLY A 25mm PARTICLE BOARD BASE FOR THE BUILT UP ROOF MEMBRANE. ALL INTERIOR AND EXTERIOR WALLS ARE NON-LOAD BEARING. ONLY THE UPPER WALL AREA IS INSULATED. THERE ARE 22 SHIPPING DOORS AND 17 MAN DOORS. THE ONLY WINDOWS ARE IN THE OFFICE AREA.

SYSTEMS : 45 GAS FIRED UNIT HEATERS PROVIDE SPACE HEATING FOR THE WAREHOUSE. 2 ROOF MOUNTED GAS FIRED HEATERS AND ELECTRIC AIR CONDITIONERS HEAT, COOL AND VENTILATE THE OFFICE AREA. 119 CEILING FANS DESTRATIFY WAREHOUSE AIR. 645 400W MERCURY VAPOUR LUMINAIRES PROVIDE INDOOR LIGHTING. 11 1000W HIGH PRESSURE SODIUM LIGHTS AND 18 400W METAL HALIDE LIGHTS PROVIDE EXTERIOR LIGHTING. THE HOT WATER AND VENTILATIONS SYSTEMS SERVE ONLY THE WASHROOMS.

ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING. ELECTRICITY PROVIDES ALL COOLING, LIGHTING, PROCESS ENERGY AND HOT WATER. WHILE THE LARGE FORK LIFTS ARE PROPANE POWERED, THE MAJORITY OF FORK LIFTS ARE RECHARGEABLE ELECTRIC. THE TOTAL 1980-1981 GAS CONSUMPTION WAS 26,840 GJ, 1.15 GJ/m^2 YEAR, 0.14 GJ/m^3 YEAR, $83,246. THE ELECTRIC CONSUMPTION WAS 5,418 GJ, 0.23 GJ/m^2, GJ/m^3 YEAR, $45,898.

Building #2



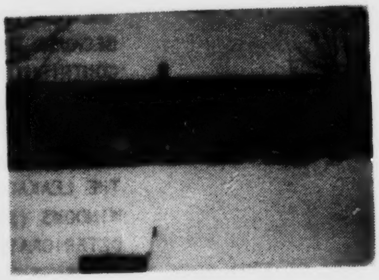


COMMENTS : THE ROOF (40%) AND INFILTRATION (46%) ARE THE MOST SIGNIFICANT CONTRIBUTORS TO THE HEAT LOAD, THE ROOF BECAUSE OF THE LARGE SURFACE AREA, AIR INFILTRATION PRIMARILY BECAUSE OF THE OPEN SHIPPING DOORS. OTHER MINOR PATHS OF AIR INFILTRATION/EXFILTRATION INCLUDE THE UNIT HEATER FLUES, EXHAUST EQUIPMENT, THE CONCRETE BLOCK FIRE WALL THAT EXTENDS ABOVE THE ROOF, AND CRACKS WHERE THE WALL AND THE ROOF MEET, OR WHERE THE WALL MATERIAL CHANGES. THE HEATING SEASON AVERAGE INFILTRATION RATE IS ESTIMATE TO BE 0.54 AIR CHANGES PER HOUR. IN WINTER, BOXCARS FILLED WITH SUBZERO TEMPERATURE PRODUCTS ARE BROUGHT INTO THE WAREHOUSE. A SIGNIFICANT AMOUNT OF HEAT IS REQUIRED TO WARM THESE PRODUCTS. IT IS DIFFICULT TO QUANTIFY AND SEPARATE THIS HEAT DEMAND WITHOUT LONG TERM RECEIVING RECORDS. THE ENERGY REQUIREMENT ASSOCIATED WITH THIS RECEIVING PROCEDURE IS INCLUDED IN THE INFILTRATION HEAT LOSS, THEREFORE THE AIR CHANGE RATE IS POSSIBLY ABOVE THE TRUE VALUE.

THE INFILTRATION PROBLEM HAS BEEN ADDRESSED BY INSTALLING CLEAR PLASTIC STRIP CURTAINS AT SHIPPING DOORS THAT MUST REMAIN OPEN. AN "AIR CURTAIN" INSTALLED ON ONE SHIPPING DOOR AS A TEST IS NO LONGER USED SINCE IT COULD NOT PERFORM SATISFACTORILY.

CEILING MOUNTED FANS BRING BOTH WARM AIR AND PROPANE FORK LIFT TRUCK EXHAUST FUMES (CO) BACK TO THE FLOOR LEVEL. THIS POLLUTION PROBLEM HAS BEEN HAS BEEN ADDRESSED BY SWITCHING TO ELECTRIC VEHICLES WHERE POSSIBLE, AND INSTALLING CATALYTIC PURIFIERS IN THE PROPANE FORK LIFT TRUCKS. AIR QUALITY IS CONSTANTLY MONITORED.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY



FILE NUMBER : 20601-03

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : BUILT IN 1958; USED AS WAREHOUSE FROM 1958 TO 1980; NOW RENTED TO A FURNITURE MANUFACTURER AS MANUFACTURING, STORAGE, DISTRIBUTION AND OFFICE SPACE.

STRUCTURE : A SMALL ONE STOREY; 280m² FLOOR AREA BUILDING OF WHICH 15% IS OFFICE SPACE. THERE IS A 40m² BASEMENT BELOW THE OFFICE AREA. THE WALLS ARE LOAD BEARING, 250 mm CONCRETE BLOCK FACED WITH 100 mm STONE OR BRICK VENEER ON THE FRONT OF THE BUILDING. THE PLYWOOD ROOF DECK IS 4.3m ABOVE THE MAIN FLOOR. THE ROOF STRUCTURE IS WOOD JOISTS ON GLULAM COLUMNS AND BEAMS. THE OFFICE FLOOR ABOVE THE BASEMENT IS STANDARD WOOD JOIST CONSTRUCTION. THE WALLS AND ROOF ARE UNINSULATED. THERE ARE TWO SHIPPING DOORS.

SYSTEMS : NATURAL GAS FIRED UNIT HEATERS CIRCULATE HEAT TO THE WAREHOUSE AND PRODUCTION AREA. A GAS-FIRED, FORCED AIR FURNACE LOCATED IN THE BASEMENT HEATS THE OFFICES.

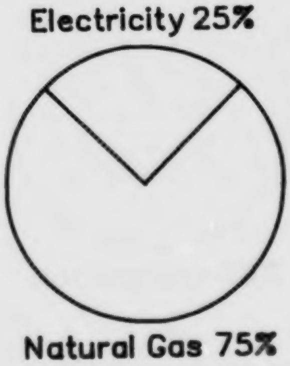
THERE IS A SMALL WINDOW AIR CONDITIONER FOR THE OFFICE AREA. FLUORESCENT FIXTURES SUPPLY ALL LIGHTING EXCEPT FOR SOME INCANDESCENT OUTDOOR LIGHTING.

THE HOT WATER AND VENTILATION SYSTEMS ONLY SERVE THE WASHROOMS.

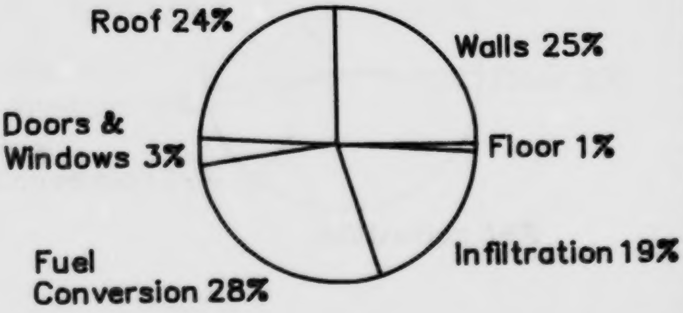
ENERGY : HEATING IS PROVIDED BY NATURAL GAS; LIGHTING, WATER HEATING, COOLING AND PROCESS REQUIREMENTS BY ELECTRICITY. THE TOTAL 1981-1982 GAS CONSUMPTION WAS 485 GJ; $2,159; 1.73 GJ/m² YEAR; 0.37 GJ/m³ YEAR. ELECTRICAL CONSUMPTION WAS 60.0 GJ, $717, 0.21 GJ/m².

Building #3

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : DUE TO ITS SIZE, THIS BUILDING PERFORMS MORE LIKE AN UNINSULATED HOUSE THAN AN INDUSTRIAL BUILDING. THE TRANSMISSION LOSSES TROUGH THE ROOF (33%) AND WALLS (39%), AND INFILTRATION (26%) ARE THE MAIN CONTRIBUTORS TO THE HEATING LOAD. THE ROOF AND WALLS HAVE SIMILAR SURFACE AREAS AND BECAUSE THEY ARE ESSENTIALLY UNINSULATED THEY MAKE COMPARABLE CONTRIBUTIONS TO THE HEAT LOSS. EVEN THOUGH THE WINDOWS ARE SINGLE GLAZED, THEY ONLY ACCOUNT FOR 2% OF THE HEAT LOSS.

THE AIR LEAKAGE RATE OF 1.22 AIR CHANGES PER HOUR IS HIGHER THAN AVERAGE. THE LEAKAGE PATHS INCLUDE THE SHIPPING DOORS (PARTICULARLY WHEN OPEN), THE WINDOWS (SOME OF WHICH ARE BROKEN OR DO NOT LATCH, AND THE CAULKING IS DETERIORATED), CRACKS IN THE BLOCK WALLS, AND THE WALL/ROOF JOINT, DESPITE THE BATT INSULATION THAT HAS BEEN PLACED THERE

THOUGH THE FORCED AIR FURNACE IS INTENDED TO HEAT THE OFFICE AREA ONLY, THE UNUSED SUPPLY AND RETURN AIR DUCTWORK TO THE WAREHOUSE IS NOT COMPLETELY CLOSED OFF. THE WAREHOUSE HEATING IS MANUALLY SET BACK TO 10°C AT NIGHT WHILE THE OFFICE IS LEFT AT 22°C.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-04

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : BUILT IN 1967; RENTED TO RETAIL/DISTRIBUTION BUSINESS FROM 1967 TO 1982. IT IS NOW OCCUPIED BY OWNER TO STORE HOUSE FURNISHINGS.

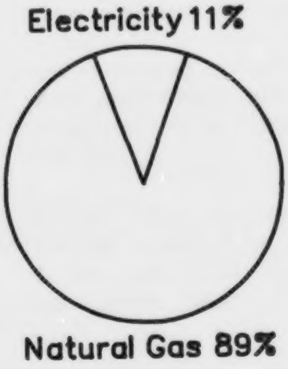
STRUCTURE : THE BUILDING IS ONE STOREY WITH A SMALL MEZZANINE AREA 3 m ABOVE THE FLOOR. THE GROUND FLOOR AREA IS 928 m^2, ALL OF WHICH IS STORAGE SPACE. THE 6.7 m HIGH CONCRETE BLOCK WALLS ARE ALL LOAD BEARING. THEY ARE STIFFENED BY BLOCK BUTTRESSES AT THE BEAM LOCATIONS. THE ROOF IS FLAT, A TYPICAL METAL DECK ON O.W.S. JOISTS, SUPPORTED IN TURN ON STEEL BEAMS AND INTERIOR COLUMNS OR THE EXTERIOR BLOCK WALLS. THERE ARE FOUR SHIPPING DOORS AND TWO MAN DOORS.

SYSTEMS : A GAS FIRED RADIANT HEATING SYSTEM MOUNTED JUST BELOW THE ROOF JOISTS HEATS THE CIRCULATION AREAS. THERE ARE NO WINDOWS, SO EVEN THOUGH AN EFFICIENT HIGH INTENSITY DISCHARGE LIGHTING SYSTEM WAS INSTALLED, SOME FLUORESCENT AND INCANDESCENT FIXTURES ARE INCLUDED TO AVOID THE START UP DELAY UNTIL THE H.I.D. FIXTURES COME ON.

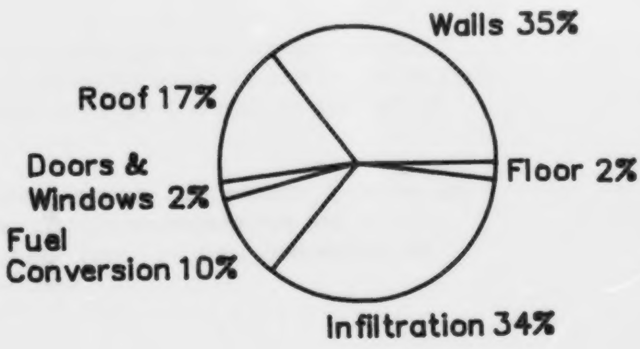
ENERGY : HEATING IS PROVIDED BY NATURAL GAS, LIGHTING BY ELECTRICITY. THERE ARE NO EXHAUST OR HOTWATER SYSTEMS. THE 1981-82 GAS CONSUMPTION WAS 1208 GJ; 1.3 GJ/m^2 YEAR; 0.19 GJ/m^3 YEAR, $5,414. THE ELECTRICAL CONSUMPTION IS NOT SEPARATELY METERED, HOWEVER IT IS ESTIMATED TO BE 60 GJ/YEAR.

Building #4

Energy Supply Cost

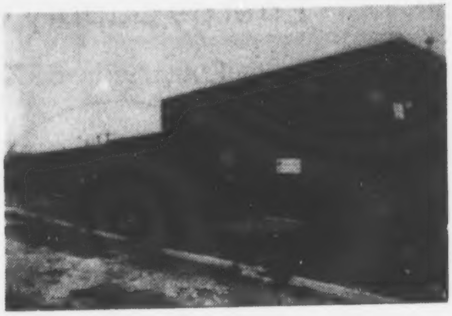


Heat Loss Breakdown



COMMENTS : IN THIS RELATIVELY SMALL BUILDING THE UNINSULATED WALLS (41%) AND AIR LEAKAGE (38%) ARE THE MAJOR CONTRIBUTORS TO THE HEATING LOAD. THE INSULATED ROOF ACCOUNTS FOR 19% . THE LOW FLUE GAS TEMPERATURE AND THE LOW ENERGY COST INDICATE THAT THE RADIANT HEATING SYSTEM IS OPERATING EFFICIENTLY. HOWEVER, COMPARED TO OTHER BUILDINGS THIS BUILDING IS RELATIVELY EXPENSIVE TO HEAT. THIS IS LARGELY DUE TO TRANSMISSION LOSS THROUGH THE WALLS. ALSO, THERE ARE SEVERAL OBVIOUS LOCATIONS OF AIR INFILTRATION. THE DOORS ARE NOT WEATHERSTRIPPED, THE DOCK LEVELLER IS NOT SEALED, THE PLYWOOD DAMPERS ON THE DOOR GRILLS ARE NOT SCREWED DOWN. THE NATURAL VENTILATION RATE IS ESTIMATED TO BE 0.9 AIR CHANGES PER HOUR. EFFLORESCENCE ON INTERIOR WALL SURFACES ESPECIALLY THE WINDWARD WALLS INDICATES INWARD MOISTURE MOVEMENT THROUGH BLOCK WORK. THE WATER PENETRATION IS MOST PRONOUNCED WHERE THE STEEL JOISTS BEAR ON THE BLOCK BUTTRESSES. THE GREATEST WETTING OF THE BLOCK WALLS OCCURS ADJACENT TO THE DOWNSPOUTS, SUGGESTING INADEQUATE DRAINAGE. LARGE AREAS OF THE WALL APPEAR TO BE DAMP FOR LONG PERIODS OF TIME. THIS REDUCES THE THERMAL RESISTANCE OF THESE WALLS.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY



FILE NUMBER : 20601-05

BUILDING TYPE : LIGHT INDUSTRIAL BUILDING

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE ORIGINAL BUILDING WAS BUILT IN 1969 WITH ADDITIONS IN 1971, 1973 AND 1976. OWNED AND OPERATED BY THE BUILDING OCCUPANT, THE BUILDING IS USED PRIMARILY FOR DIE MAKING AND PLASTICS MOLDING.

STRUCTURE : A ONE STOREY BUILDING WITH A TOTAL FLOOR AREA OF 858 m^2, OF WHICH 25 m^2 ARE OFFICES. THE WALLS ARE 3.7 m HIGH IN THE CONCRETE BLOCK SECTION AND 4.7 m HIGH IN THE METAL BUILDING (TO THE UNDERSIDE OF THE ROOF DECK). 250 mm LOAD BEARING CONCRETE BLOCK WALLS SUPPORT OPEN WEB STEEL JOISTS IN THE ORIGINAL BUILDING AND FIRST TWO ADDITIONS. THE 1976 ADDITION IS OPEN WEB STEEL JOISTS ON A BRACED STEEL FRAME, CLAD WITH PREFINISHED SHEET METAL. THERE ARE TWO SHIPPING DOORS, EIGHT MAN DOORS AND WINDOWS ON THE EAST, WEST AND SOUTH SIDES. ONLY THE STEEL CLAD WALLS IN THE 1976 ADDITION AND THE CONCRETE BLOCK WALLS OF THE ORIGINAL BUILDING ARE UNINSULATED.

SYSTEMS : THE OFFICE AREA IS HEATED BY ELECTRIC BASE BOARD HEATERS. THE ORIGINAL BUILDING AND FIRST TWO ADDITIONS ARE HEATED BY TWO GAS FIRED FORCED AIR FURNACES WITH THE SUPPLY DUCTWORK EMBEDDED IN THE CONCRETE SLAB.

THE 1976 ADDITION HAS A RADIANT GAS FIRED HEATING SYSTEM MOUNTED JUST BELOW THE ROOF JOISTS.

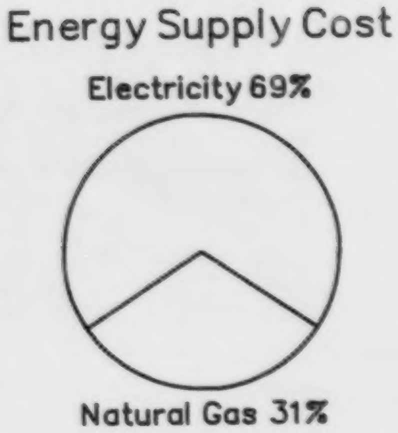
FLUORESCENT FIXTURES PROVIDE LIGHTING FOR THE ENTIRE BUILDING.

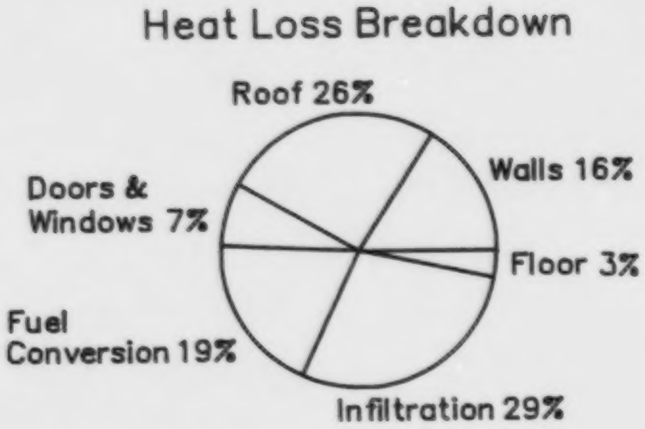
PROCESS EQUIPMENT IN THE 1976 ADDITION PROVIDES MUCH OF THE HEAT FOR THIS AREA AND CONSEQUENTLY THE RADIANT HEATING IS USED SPARINGLY. TWO EXHAUST FANS IN THE 1976 ADDITION PURGE EXCESS PROCESS HEAT TO THE OUTSIDE WHEN THE BUILDING CANNOT USE THAT HEAT. IN THE WINTER THE EXCESS HEAT IN THE 1976 ADDITION IS BLOWN THROUGH THE REST OF THE BUILDING BY TWO FANS AND AN EXISTING FORCED AIR FURNACE.

SUMMER COOLING IS PROVIDED BY COOLING COILS IN THE FURNACE DUCTWORK, SINCE MOST SUMMER HEAT GAIN IS THROUGH THE ROOF. THE ROOF IS SPRINKLERED AS REQUIRED USING ORDINARY GARDEN HOSES AND SPRAYERS FOR EVAPORATIVE COOLING.

ENERGY : NATURAL GAS IS USED ONLY FOR SPACE HEATING. ALL PROCESS, LIGHTING AND COOLING IS ELECTRIC. THE TOTAL 1981-82 GAS CONSUMPTION WAS 511 GJ, \$2,341; 0.60 GJ/m^2 YEAR, 0.14 GJ/m^3 YEAR. ELECTRIC CONSUMPTION WAS 463 GJ/YEAR, \$5,157. 0.54 GJ/m^2 YEAR.

Building #5





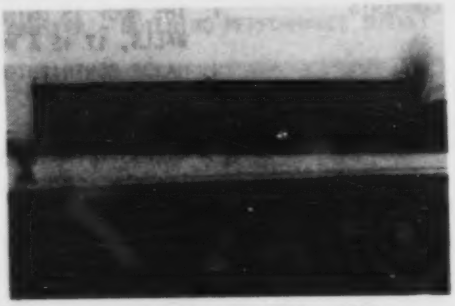
COMMENTS : THE ROOF HEAT LOSS IS 35%, AIR CONTRIBUTES 35% AND THE WALLS 22%. THE ANNUAL SPACE HEATING ENERGY IS ONLY MARGINALLY GREATER THAN THE ANNUAL CONSUMPTION OF ELECTRICAL ENERGY, HOWEVER, THE COST OF NATURAL GAS IS MUCH LESS THAN THE COST OF LIGHTING AND PROCESS ELECTRICAL ENERGY, DUE TO THE HIGHER COST OF ELECTRICITY. THAT PROCESS ELECTRICAL ENERGY IS REUSED FOR SPACE HEATING. THE EQUIPMENT CHILLERS DUMP THE HEAT INTO THE REAR SECTION OF THE BUILDING. TWO THERMOSTATICALLY CONTROLLED BLOWERS NEAR THE CEILING FORCE THAT HOT AIR THROUGH THE REST OF THE BUILDING THROUGH EXISTING FURNACE DUCTWORK. THE GAS HEATING SYSTEM FOR THE PLASTICS MOLDING AREA ONLY OPERATES AT NIGHT, AND EARLY MORNING ON TYPICAL PRODUCTION DAYS. THE HEAT OUTPUT OF THE MOLDING EQUIPMENT WAS NOT MEASURED.

AS WELL AS ENERGY REUSE, SPECIFIC ENERGY CONSERVATION MEASURES HAVE BEEN IMPLEMENTED. THERMOSTATS ARE SET BACK NIGHTS AND WEEKENDS, WINDOWS HAVE BEEN DOUBLE GLAZED WITH PLASTIC, AND UNUSED DOORS HAVE BEEN INSULATED AND CAULKED SHUT. THE NEWEST ADDITION IS WELL INSULATED, AND MEASURES HAVE BEEN TAKEN TO REDUCE INFILTRATION. OF PARTICULAR INTEREST IS THE HEAVY CANVAS CURTAIN THAT ISOLATES THE SHIPPING AREA WHEN THE LARGE DOOR IS OPEN. THIS IS EFFECTIVE SINCE MOST SHIPMENTS ARE SMALL, AND CAN BE CONTAINED WITHIN THE CURTAINED AREA. THE AVERAGE AIR INFILTRATION RATE HAS BEEN ESTIMATED TO BE 0.83 AIR CHANGES PER HOUR BASED ON THE 1981-82 WEATHER AND FUEL CONSUMPTION.

BOTH THE ELECTRICAL AND NATURAL GAS UTILITIES BILL THIS CUSTOMER TWICE MONTHLY, RESULTING IN A HIGHER PER UNIT ENERGY COST. THERE ARE TWO ELECTRICAL METERS.

THERE ARE NO CRACK CONTROL JOINTS IN THE EAST WALL, AND THERE ARE RANDOM CRACKS.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE STUDY



FILE NUMBER : 20601-06

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

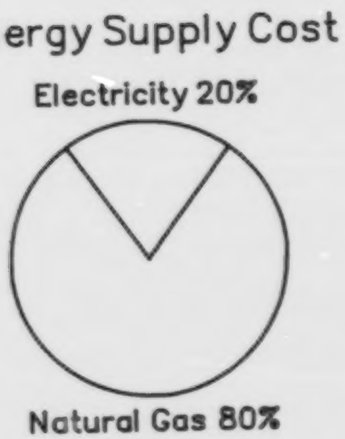
OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OWNER/OCCUPANT IN 1965. THE BUILDING IS USED AS A WHOLESALE DISTRIBUTION CENTER FOR SMALL HOUSEHOLD GOODS AND TOYS.

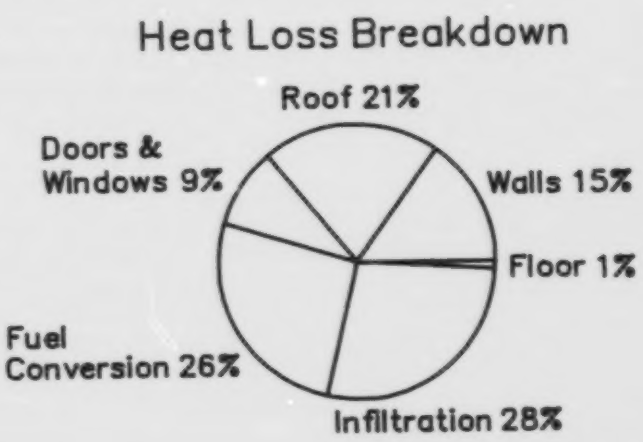
STRUCTURE : THE TOTAL FLOOR AREA IS 1162 m^2, OF WHICH 115m^2 IS OFFICE AREA (10%). THE BUILDING IS ONE STOREY; 4.6 m HIGH TO UNDERSIDE OF THE ROOF DECK. THE ROOF STRUCTURE (STEEL JOISTS AND METAL DECK) IS SUPPORTED ON STEEL BEAMS AND COLUMNS. THE EXTERIOR CONCRETE BLOCK WALLS ARE NON-LOAD BEARING. THE SHIPPING AREA IS ISOLATED AT THE BACK OF THE BUILDING. THERE ARE THREE SHIPPING DOORS, FIVE MAN DOORS. THERE ARE EIGHT WINDOWS PLUS A BAND OF CORRUGATED TRANSLUCENT F.R.P. (130m^2) AT THE WALL/ROOF JUNCTION THAT INTRODUCES NATURAL LIGHT IN THE WAREHOUSE AREA. THE WALLS AND ROOF ARE UNINSULATED.

SYSTEMS : THE WAREHOUSE AND RECEIVING AREAS ARE HEATED BY NATURAL GAS UNIT HEATERS. THE OFFICE AREA HAS A FORCED AIR NATURAL GAS FURNACE. THERE IS ONE SMALL WINDOW AIR CONDITIONER SERVING THE OFFICE AREA. BOTH HEATING SYSTEMS ARE SET AT 13°C OVERNIGHT AND ON WEEKENDS, AND AT 18°C DURING EACH WORKING DAY. THERE ARE FOUR CEILING FANS IN THE WAREHOUSE. THE ONLY EXHAUST SYSTEMS ARE IN THE WASHROOMS. THE INTERIOR LIGHTING IS FLUORESCENT.

ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING. ELECTRICITY OPERATES ALL LIGHTING, FANS, EQUIPMENT. THE 1981-82 SPACE HEATING BILL WAS 1,813 GJ; $8,046; 1.56 GJ/$m^2$ YEAR; 0.34 GJ/m^3 YEAR. ELECTRICAL USE FOR THE SAME PERIOD WAS 185 GJ; $2,003: 0.16 GJ/$m^2$.

Building #6


Energy Supply Cost

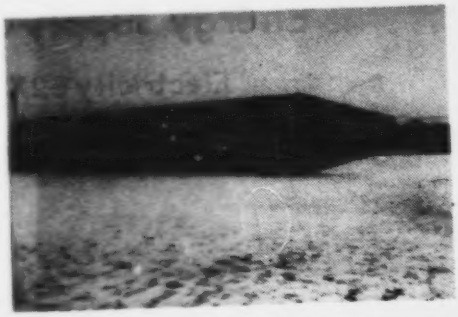

Heat Loss Breakdown

COMMENTS : THE ROOF IS UNINSULATED, AND SINCE THE ROOF AREA IS 2.5 TIMES THAT OF THE WALLS, IT IS A MAJOR CONTRIBUTOR TO THE HEATING LOAD (29%). THE OTHER MAJOR CONTRIBUTORS ARE AIR INFILTRATION (38%) AND THE UNINSULATED WALLS (20%).

THE BUILDING IS ALMOST 20 YEARS OLD, AND CRACKS HAVE DEVELOPED IN THE BLOCK WALLS. THE WINDOW WEATHERSTRIPPING IS BROKEN AND THE EXTERIOR PAINT ON THE WALLS AND WINDOWS HAS DETERIORATED. ALL CAULKING HAS DRIED AND CRACKED OR HAS SEPARATED FROM THE SUBSTRATE. THE VARIOUS ENERGY CONSERVATION MEASURES ALREADY INSTITUTED INCLUDE NIGHT AND WEEKEND THERMOSTAT SETBACK, ADDING PLASTIC FILM TO THE SINGLE GLAZED WINDOWS, AND SEPARATING THE SHIPPING AREA FROM THE SHOWROOM/WAREHOUSE WITH A WALL AND SWING DOORS.

THE INTERIOR LIGHTING IS 5 m ABOVE THE FLOOR, 3 m ABOVE THE HIGHEST MERCHANDISE. THE WINDOWS ACCOUNT FOR 11% OF THE HEAT LOSS, A RELATIVELY HIGH CONTRIBUTION FOR THIS TYPE OF BUILDING BUT THAT IS LARGELY DUE TO THE TRANSLUCENT F.R.P. CORRUGATED PANELS. THE METHOD OF SEALING THE CORRUGATED PLASTIC PANELS AT THE WALL AND ROOF COULD NOT BE DETERMINED, BUT THIS MAY BE A SIGNIFICANT SOURCE OF AIR LEAKAGE. THE ESTIMATED NATURAL VENTILATION RATE OF 1.43 AIR CHANGES PER HOUR IS RELATIVELY HIGH AND SOME SIMPLE AND INEXPENSIVE MEASURES TO REDUCE AIR LEAKAGE WOULD BE WELL WORTHWHILE.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY



FILE NUMBER : 20601-07

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE BUILDING WAS CONSTRUCTED FOR THE CURRENT OWNER/OCCUPANT IN 1981. THE BUILDING IS USED TO MANUFACTURE, STORE, AND DISTRIBUTE LEATHER PRODUCTS. ONE THIRD IS PRODUCTION/OFFICE AREAS, AND TWO THIRDS IS WAREHOUSE AND SHIPPING AREAS.

STRUCTURE : THE BUILDING IS LARGELY ONE STOREY, 1909 m^2 FLOOR AREA, 5.5 m TO THE UNDERSIDE OF THE ROOF DECK. THERE IS A STORAGE MEZZANINE ABOVE PART OF THE OFFICE AREAS. THE OFFICE AREA TOTALS 240 m^2 (13%). THE EXTERIOR WALLS ARE AN INTERNAL WYTHE OF LOAD BEARING CONCRETE BLOCK, RIGID INSULATION, AND A 100 mm DECORATIVE BLOCK EXTERIOR FINISH. THE INTERIOR STRUCTURE IS STEEL BEAMS AND COLUMNS, SUPPORTING STEEL JOISTS AND A FLAT ROOF. THE ENCLOSURE IS EXCEPTIONALLY WELL INSULATED (ROOF RSI 3.0, WALLS RSI 2.6, FOUNDATION WALL RSI 1.8). THERE ARE NO WINDOWS IN THE PRODUCTION AREA.

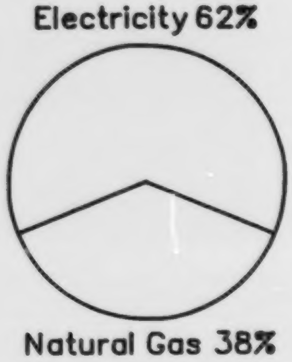
SYSTEMS : THE PRODUCTION/WAREHOUSE AREA IS HEATED BY A GAS FIRED, RADIANT TUBE SYSTEM, 5.0 m ABOVE THE FLOOR. THE OFFICE IS HEATED AND AIR CONDITIONED BY A ROOFTOP FORCED AIR SYSTEM, SET TO PROVIDE 10% FRESH AIR TO THE RETURN AIR DUCT. BOTH SYSTEMS ARE AUTOMATICALLY SETBACK TO 10° C AT NIGHT AND ON WEEKENDS. THE KITCHEN AND BATHROOMS HAVE MECHANICAL EXHAUST.

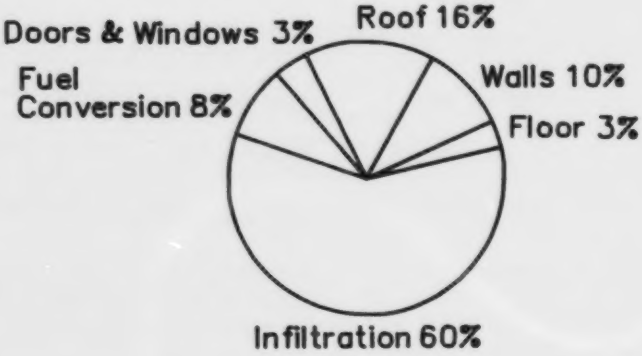
INTERIOR LIGHTING IS FLUORESCENT; EXTERIOR IS H.I.D., BOTH ON AUTOMATIC TIMERS.

A SMALL GAS FIRED BOILER PROVIDES SOME PROCESS HEAT.

ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING, AND A SMALL QUANTITY OF PROCESS HEAT. ELECTRICITY OPERATES THE LIGHTING, COOLING, AND MOST PROCESS EQUIPMENT. THE 1982 GAS CONSUMPTION WAS 563 GJ; $2,659; 0.29 GJ/$m^2$ YEAR; 0.055 GJ/m^3 YEAR. THE 1982 ELECTRICAL CONSUMPTION WAS 371 GJ; $4,253, 0.19 GJ/$m^2$ YEAR.

Building #7


Energy Supply Cost


Heat Loss Breakdown

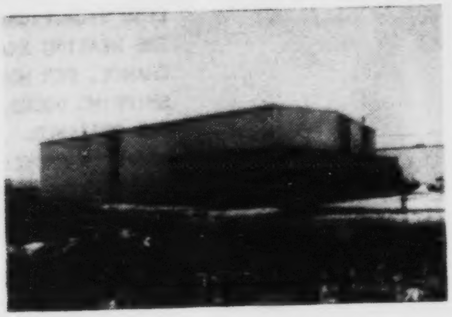
COMMENTS : THIS IS A WELL DESIGNED AND WELL INSULATED BUILDING. SPACE HEATING ENERGY CONSUMPTION PER UNIT FLOOR AREA IS TWO THIRDS THAT IN A COMPARABLE UNINSULATED BUILDING.

INFILTRATION ACCOUNTS FOR MOST (65%) OF THE HEATING ENERGY BUT THE AIR CHANGE RATE (0.62 AIR CHANGES PER HOUR) SUGGESTS THAT THE BUILDING IS NOT ABNORMALLY LEAKY. INFILTRATION IS CONTROLLED AT THE RECEIVING AREA BY FELT PADS OVER THE DOCK LEVELLERS. BLOCK WALLS SEPARATE THE LOADING DOCK FROM THE STORAGE AREA. THE FORK LIFT DOOR BETWEEN THE TWO HAS A CLEAR PLASTIC STRIP CURTAIN. THE RADIANT HEATING TUBE PASSES INTO THE RECEIVING AREA, NECESSITATING TWO 1.5 m^2 OPENINGS. HOWEVER, BECAUSE OF THE STRIP CURTAIN, THE COLD AIR WILL TEND TO STAY IN THE RECEIVING AREA.

THE WEATHERSTRIPPING AT THE BOTTOM OF ALL DOORS IS NOT ADJUSTED TO STOP AIR FLOW. THE CRACK CONTROL JOINTS IN THE BLOCK WALLS ARE NOT FILLED WITH SEALANT. THE RESULTING CRACKS LEAD TO UNCOMFORTABLE DRAFTS UNDER HIGH WIND CONDTIONS.

THE HEAT LOSS THROUGH THE ROOF (16%) AND WALLS (12%) IS RELATIVELY SMALL. THE CO-RAY-VAC HEATING SYSTEM DELIVERS THE GREATEST CONCENTRATION OF RADIANT HEAT IN THE SEWING MACHINE AREA. IT APPEARS THAT HEAT DISTRIBUTION IS A PROBLEM IN THIS AREA AS OPERATORS MENTIONED HOT UPPER BODIES, AND COLD LEGS AND FEET. SOME SECTIONS OF THE RADIANT TUBE HAVE BEEN COVERED TO REDUCE THE UNCOMFORTABLY HOT CONDITIONS FOR THE SEDENTARY WORKERS.

THE EXHAUST FANS IN THE WASHROOMS ARE NOISY, AND NOT USED. IN THE WINTER THE DUCTWORK ALLOWS WASHROOM AIR TO ESCAPE WITHOUT FAN OPERATION.



FILE NUMBER : 20601-08

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OWNER/COMPANY IN 1977. IT US USED FOR THE STORAGE AND CLEANING OF FURNITURE, PARTICULARLY WATER DAMAGED FURNITURE.

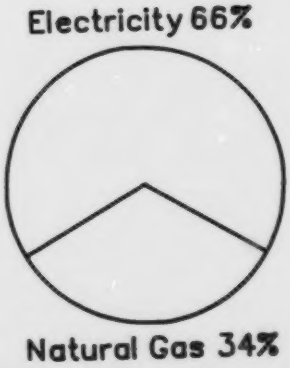
STRUCTURE : THE BUILDING AS A TYPICAL PRE-ENGINEERED INSULATED STEEL SHELL ENCLOSING 553 m^2 OF GROUND FLOOR AREA. THE OFFICE AREA AT THE FRONT OF THE BUILDING IS 125 m^2 (24%) . THERE IS A 125 m^2 SHOWROOM MEZZANINE ABOVE THE OFFICES. THE MEZZANINE FLOOR IS PRECAST CONCRETE SLABS ON PERIMETER CONCRETE BLOCK WALLS. THE ROOF IS A LOW SLOPE, PREFINISHED STEEL DECK ON STEEL PURLINS. LIKE THE WALLS, IT IS INSULATED WITH FIBERGLASS BATTS, COVERED WITH A VINYL VAPOUR BARRIER. THE ROOF IS 6.6 m ABOVE THE FLOOR ON AVERAGE. THERE ARE TWO SHIPPING DOORS. THE ONLY WINDOWS ARE IN THE OFFICE AREA.

SYSTEMS : THE STORAGE AREA IS HEATED BY NATURAL GAS UNIT HEATERS. THE OFFICES ARE HEATED BY A NATURAL GAS FORCED AIR FURNACE. THE OFFICE ALSO HAS CENTRAL AIR CONDITIONING. THESE HEATING SYSTEMS ARE SET BACK FROM 20°C TO 10°C AT NIGHT AND ON WEEKENDS. THE MEZZANINE SHOWROOM ABOVE THE OFFICES IS HEATED WITH ELECTRIC BASE BOARDS. PROCESS EQUIPMENT CONSISTS OF A LARGE DEHUMIDIFIER IN AN ISOLATED ROOM WHERE WATER DAMAGED FURNITURE IS DRYED. ALL LIGHTING IS FLUORESCENT.

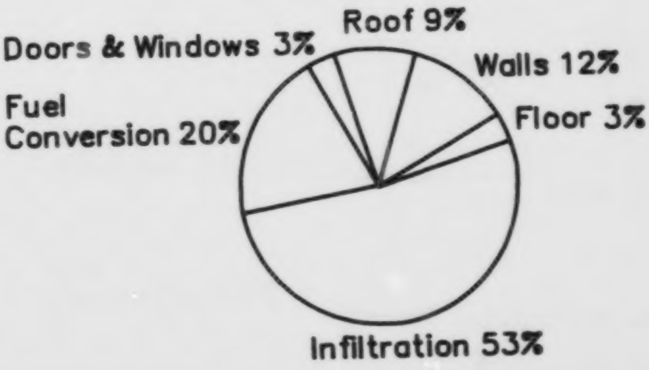
ENERGY : NATURAL GAS PROVIDES MOST OF THE SPACE HEATING HOWEVER, THE MEZZANINE HAS ELECTRIC HEATERS. THE ELECTRICAL CONSUMPTION FOR SPACE HEATING IS NOT SEPARATELY METERED. IT HAS BEEN INCLUDED IN THE COMPUTER ANALYSIS WITH OTHER ELECTRICAL INTERNAL GAIN. OTHER ELECTRIC CONSUMPTION IS PROCESS DEHUMIDIFICATION, LIGHTING AND SPACE COOLING. THE 1982 GAS CONSUMPTION WAS 403 GJ, $1,843, 0.73 GJ/$m^2$ YEAR, 0.11 GJ/m^3 YEAR. THE 1981 ELECTRICAL CONSUMPTION (1982 DATA INCOMPLETE) WAS 360 GJ, $3,600, 0.65 GJ/$m^2$ YEAR. THE ELECTRICAL ENERGY CONSUMPTION EQUALS SPACE HEATING IN THIS BUILDING.

Building #8

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE HEAT LOSS THROUGH THE INSULATED WALLS (13%) AND ROOF (12%) IS MUCH LESS SIGNIFICANT THAN NATURAL AIR INFILTRATION WHICH ACCOUNTS FOR 67%. THE HEATING SEASON AVERAGE INFILTRATION RATE IS ESTIMATED TO BE 1.26 AIR CHANGES PER HOUR. SUCH AN AIR CHANGE RATE IS OFTEN ASSOCIATED WITH OPEN SHIPPING DOORS, HOWEVER, NO INFORMATION ABOUT THE SHIPPING DOORS OPERATION WAS OBTAINED. ALSO, THE WEATHERSTRIPPING AT THE BOTTOM OF THE SHIPPING DOORS IS BROKEN. THERE IS NO WEATHERSTRIPPING AT THE MAN DOOR SILLS. THE POINT WHERE THE FURNACE FLUE PENETRATES THE ROOF APPEARS TO BE A SOURCE OF BOTH WATER AND AIR LEAKAGE.

THE NATURAL GAS UTILITY INVOICES THIS BUILDING TWICE A MONTH, A PROCEDURE THAT TENDS TO KEEP THE PER UNIT COST OF FUEL AT THE HIGH END OF THE RATE STRUCTURE. STILL, THE COST OF GAS ($1,843) IS ONLY HALF THAT OF ELECTRICITY ($3,600).

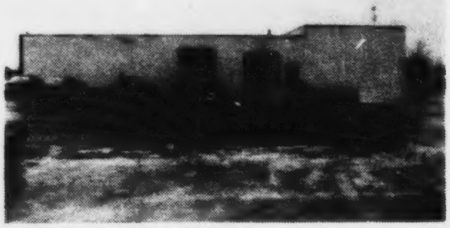
FILE NUMBER : 20601-09

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO



OCCUPANCY : BUILT IN 1979 FOR THE CURRENT OWNER/OCCUPANT, THE BUILDING IS USED FOR THE STORAGE, CLEANING AND PACKAGING OF APPLES. THERE ARE TWO LARGE COLD STORAGE ROOMS AT THE REAR OF THE BUILDING.

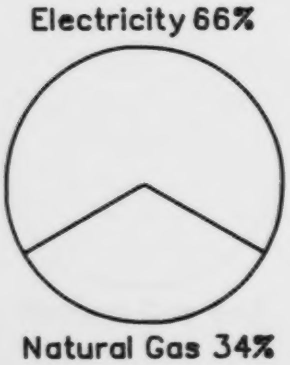
STRUCTURE : A ONE STOREY, 553m² FLOOR AREA BUILDING OF WHICH 25m² (5%) IS OFFICE AREA. THE ROOF IS A TYPICAL FLAT BUILT-UP ROOF MEMBRANE ON INSULATION AND A STEEL DECK, SUPPORTED IN TURN ON OPEN WEB STEEL JOISTS. THE ROOF DECK IS 4.6 m ABOVE THE FLOOR. THE ROOF IS SUPPORTED ON INTERIOR STEEL BEAMS AND COLUMNS, OR THE EXTERIOR CONCRETE BLOCK WALLS. THE WALLS AND FLOOR SLAB ARE NOT INSULATED. THE ROOF AND WALLS OF THE COLD STORAGE ROOMS (165m²) ARE INSULATED WITH POLYURETHANE. THESE ROOMS ARE KEPT AT 2°C. THERE IS ONE SHIPPING DOOR, THREE MAN DOORS. THE ONLY WINDOWS ARE IN THE SMALL OFFICE AREA.

SYSTEMS : THE BUILDING IS HEATED BY NATURAL GAS UNIT HEATERS. THE APPLE DRYER IS A MODIFIED UNIT HEATER AT FLOOR LEVEL THAT DELIVERS HOT MOIST AIR TO THE BUILDING. THE TWO APPLE STORAGE ROOMS ARE CHILLED BY TWO LARGE ELECTRIC REFRIGERATION UNITS THAT TRANSFER THE HEAT TO THE PRODUCTION AREA. ALL LIGHTING IS PROVIDED BY FLUORESCENT FIXTURES. THERE IS ONE BATHROOM EXHAUST AND A LARGE EXHAUST FAN WHICH US USED TO DISPOSE OF EXCESS PROCESS HEAT FROM THE APPLE DRYER ONLY DURING THE SUMMER MONTHS.

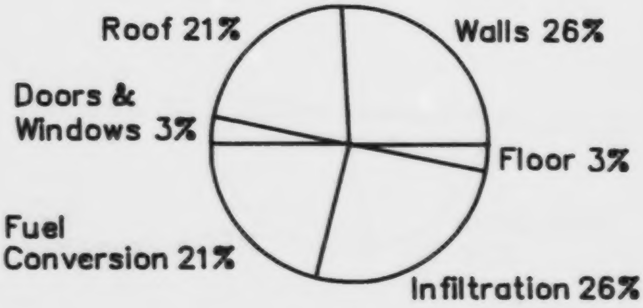
ENERGY : HEATING AND PROCESS DRYING IS PROVIDED BY NATURAL GAS, LIGHTING AND PROCESS COOLING BY ELECTRICITY. THE TOTAL NATURAL GAS CONSUMPTION FROM JULY 1981 TO JULY 1982 WAS 512 GJ, $2,350, HOWEVER, MUCH OF THAT IS PROCESS HEAT. THE SPACE HEATING REQUIREMENT IS ESTIMATED TO BE 483 GJ, $2,256, 0.67 GJ/m² YEAR, 0.17 GJ/m³ YEAR. THE ELECTRIC CONSUMPTION WAS 375 GJ, $4,313, 0.52 GJ/m² YEAR. THE HEAT FROM THE CHILLERS IS DELIVERED INTO THE SHIPPING AREA, PROVIDING MOST OF THE HEAT REQUIRED THERE.

Building #9

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE UNINSULATED WALLS CONSTITUTE THE LARGEST PERCENTAGE OF THE HEAT LOSS (26%). THE ROOF (27%) AND THE AIR INFILTRATION (32%) ACCOUNT FOR MOST OF THE REMAINDER. THE AVERAGE NATURAL VENTILATION RATE IS ESTIMATED TO BE 0.82 AIR CHANGES PER HOUR, WHICH IS TYPICAL FOR SUCH A BUILDING. THE INFILTRATION IS MOSTLY ASSOCIATED WITH THE OPEN SHIPPING DOOR. "TRAILER SEALS" WOULD NOT BE USEFUL ON THE 10' x 10' DOOR SINCE THE OPENING IS WIDER THAN A STANDARD TRUCK. THE CRACKS AT THE DOCK LEVELLER ARE NOT SEALED, AND THE WEATHERSTRIPPING AT THE MAN DOOR IS INEFFECTIVE UNLESS THE DOOR IS LOCKED, WHICH IT IS NOT DURING THE DAY.

ENERGY CONSERVATION MEASURES HAVE BEEN DIRECTED AT REDUCING SPACE HEATING COSTS. THE WINDOWS ARE DOUBLE GLAZED, NON-OPENABLE UNITS, THE DOORS ARE WEATHERSTRIPPED. THE ROOF AND WALLS OF THE COLD STORAGE ROOMS ARE INSULATED WITH 50 mm OF POLYURETHANE FOAM. CEILING FANS BRING STRATIFIED HOT AIR FROM PORCESS DRYING BACK TO THE FLOOR LEVEL. THE SHIPPING AREA HEATERS ARE SET AT 10°C, THE PRODUCTION AREA HEATERS ARE SET BACK FROM 18°C TO 10°C AT NIGHT AND ON WEEKENDS. THESE MEASURES HAVE REDUCED THE REQUIREMENT FOR GAS TO SUCH AN EXTENT THAT THE COST IS HALF THAT OF THE ELECTRICAL BILL. LIGHTING AND PROCESS COOLING ARE THE MAJOR ELECTRICAL LOADS. HOWEVER, THERE DOES NOT APPEAR TO BE A SIGNIFICANT INCREASE IN THE SUMMER ELECTRICAL CONSUMPTION ASSOCIATED WITH PROCESS COOLING.

THE INTERIOR RELATIVE HUMIDITY IS HIGHER THAN NORMAL (75%) DUE TO PROCESS DRYING. THE BUILDING SHOWS NO ADVERSE EFFECTS.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-10

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : BUILT IN 1972 AND USED AS A DISTRIBUTION CENTER, IT WAS SOLD TO THE CURRENT OCCUPANT, A MOVING AND STORAGE COMPANY, IN 1977. AN ADDITION MADE AT THAT TIME IS USED AS A TRUCK REPAIR GARAGE.

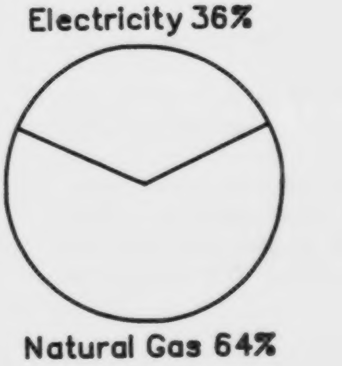
STRUCTURE : THIS IS A TYPICAL ONE STOREY WAREHOUSE. OF THE TOTAL 1,237 m^2 FLOOR AREA, 15% IS OFFICE SPACE. ABOVE THE OFFICES IS A MEZZANINE USED FOR MISCELLANEOUS STORAGE. THE ROOF DECK IS 5.9 m ABOVE THE FLOOR. IT CONSISTS OF A 'FLAT' B.U.R. WITH 40 mm INSULATION ON A STEEL DECK SUPPORTED BY OWSJ. THESE STEEL JOISTS ARE CARRIED BY THE EXTERIOR CONCRETE BLOCK WALLS, OR AN INTERIOR FRAMEWORK OF STEEL BEAMS AND COLUMNS. THE CONCRETE BLOCK WALL IS INSULATED WITH UREAFORMALDEHYDE FOAM ONLY IN THE OFFICE AREA. ALL OTHER WALLS ARE UNINSULATED, BUT ARE PAINTED ON THE EXTERIOR.

SYSTEMS : THE OFFICES ARE HEATED/COOLED BY CHROMOLOX THRU-THE-WALL UNITS, ONE PER OFFICE. THE WORK-SHOP AND WAREHOUSE ARE HEATED BY NATURAL GAS FIRED UNIT HEATERS. ALL LIGHTING IS PROVIDED BY FLUORESCENT FIXTURES. THE EXHAUST EQUIPMENT AND HOT WATER SYSTEM ARE MINOR ENERGY CONSUMERS.

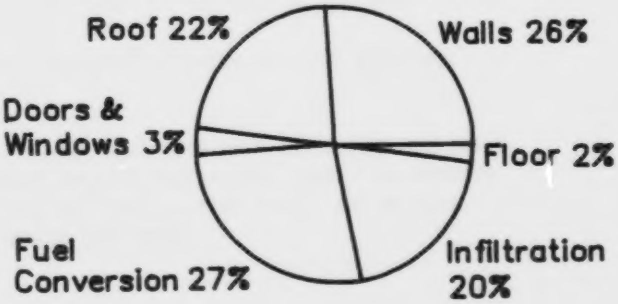
ENERGY : HEATING FOR THE WAREHOUSE AND WORKSHOP IS PROVIDED BY NATURAL GAS. HEATING AND COOLING FOR THE OFFICE AREA, AND ALL LIGHTING, IS ELECTRIC. THE 1982 GAS CONSUMPTION WAS 1,256 GJ; $5,482; 1.02 GJ/m^2 YEAR; 0.19 GJ/m^3 YEAR. THE ELECTRICAL CONSUMPTION WAS 310 GJ; $3,132, 0.25 GJ/m^2 YEAR.

Building #10

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE BUILDING IS THERMALLY ZONED WITH THE OFFICE KEPT AT 20°C THE MAINTENANCE AREA AT 18°C AND THE WAREHOUSE AT 13°C. NO NIGHT OR WEEKEND SET-BACK IS BEING USED.

THE WALLS (35%), ROOF (30%) AND AIR INFILTRATION (29%), ARE THE MOST SIGNIFICANT OF THE LOSSES CONTRIBUTING TO THE HEATING LOAD. THE NATURAL VENTILATION RATE IS ESTIMATED TO BE 0.57 AIR CHANGES PER HOUR. THE WALLS ARE LARGELY UNINSULATED, THE FOAM INSULATION IN THE BLOCK CORES AT THE NORTH WALL IS LESS EFFECTIVE THAN AN UNBROKEN LAYER OF INSULATION, DUE TO 'THERMAL BRIDGING' THROUGH THE CONCRETE.

THE ROOF AREA IS LARGER THAN THE WALL AREA, BUT THE 25 mm CONTINUOUS LAYER OF INSULATION REDUCES THE HEAT LOSS. THE ROOF MEMBRANE OVER THE 1978 ADDITION HAS EXPANDED AT THE JOINTS IN THE INSULATION BOARDS, LEAVING RIDGES OF FELT AND BITUMEN EXPOSED TO THE SUN (NO GRAVEL COVER). THIS MAY LEAD TO LEAKS, AND WET INSULATION IN THE FUTURE.

THE SOUTH AND WEST BLOCK WALLS ARE CRACKED AT THE MORTAR JOINTS. PAINT ON THE OUTSIDE OF THE BLOCK WALLS IS FLAKING OFF.

EACH DIESEL TRUCK HAS A 1500 w BLOCK HEATER WHICH IS LEFT ON WHENEVER THE TRUCK IS IN THE YARD. LEAVING AN AVERAGE OF FOUR TRUCKS CONTINUALLY PLUGGED IN FOR FOUR MONTHS WILL CONSUME 17200 kwh, OR $700 WORTH OF ELECTRICITY.

ONE UNIT HEATER HAS BEEN REMOVED FROM THE CEILING AREA ABOVE THE MEZZANINE. THE CAP ON THE FLASHING FOR THE OLD FLUE IS NOT INSULATED, ALLOWING IT TO BECOME QUITE COLD. MOISTURE CONDENSES ON THAT CAP, AND DRIPS ON THE MEZZANINE FLOOR.

FILE NUMBER : 20601-11

BUILDING TYPE : UNHEATED WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT IN 1972 FOR THE CURRENT OCCUPANT, A SUBSIDIARY/BRANCH OF A BUILDING MATERIALS SUPPLIER WITH OUTLETS ACROSS CANADA. THE FUEL BILLS ARE APPROVED IN KITCHENER AND PAID AT THE HEAD OFFICE. THE WAREHOUSE AREA IS AN UNHEATED, DRY STORAGE AREA FOR WOOD PRODUCTS. A SMALL ADMINISTRATION SPACE IS HEATED.

STRUCTURE : THE STRUCTURAL SYSTEM FOR THIS 2,280 m^2 FLOOR AREA WAREHOUSE IS GLULAM COLUMNS AND BEAMS. THE WOOD STUF FRAME WALLS ARE CLAD WITH PREFINISHED SHEET METAL ONTO PLYWOOD SHEATHING. THE FLAT ROOF DECK (6.7 m ABOVE SLAB) IS PLYWOOD ON WOOD JOISTS. THE ROOF HAS A BUILT UP MEMBRANE WHICH IS SLOPED TO CENTER DRAINS. THE WAREHOUSE WALLS AND ROOF ARE UNINSULATED SINCE THIS SPACE IS OPEN AND UNHEATED. THE OFFICE AREA IS HEATED. IT IS A ONE STOREY 67 m^2 FLOOR AREA SPACE OUTSIDE THE N.E. CORNER OF THE WAREHOUSE. THE OFFICE AREA AND THE WAREHOUSE ARE SEPARATED BY AN UNINSULATED CONCRETE BLOCK FIRE WALL. THE OFFICE ROOF IS IDENTICAL TO THE WAREHOUSE ROOF, EXCEPT THAT THE GLULAM BEAMS ARE SUPPORTED ON MASONRY AND THE ROOF HAS SOME INSULATION. THE WALLS ARE INSULATED WOOD FRAME, WITH BRICK OR CEDAR SHINGLE EXTERIOR FINISHES.

SYSTEMS : NO NATURAL GAS IS USED IN THIS BUILDING. SPACE HEATING, AIR CONDITIONING AND LIGHTING ARE ALL ELECTRIC, AS IS HOT WATER HEATING. THE OFFICE IS HEATED AND AIR CONDITIONED BY A FORCED AIR SYSTEM. THE LIGHTING IS FLUORESCENT THROUGHOUT. THE WAREHOUSE IS SPRINKLERED.

ENERGY : THE OFFICE AREA HEATING ENERGY CONSUMPTION IS INCORPORATED IN THE TOTAL MONTHLY BILL, BUT IT ONLY AMOUNTS TO AN ESTIMATED 10% OF THE TOTAL ELECTRICAL CONSUMPTION. IN 1982 THE TOTAL CONSUMPTION WAS 134,200 kwh, 483 GJ, $4,959. LIGHTING IN THE WAREHOUSE, HEATING IN THE FOREMAN'S OFFICE, THE ROOF DRAIN HEATER, AND EXTERNAL LIGHTING IS ESTIMATED TO HAVE CONSUMED 120,699 kwh. THE SPACE HEAT ENERGY FOR THE OFFICE AREA IS ASSUMED TO BE THE DIFFERENCE, 13,501 kwh, 48.6 GJ, $499, 0.72 GJ/$m^2$ YEAR, 0.298 GJ/m^3 YEAR. THE NON-SPACE HEAT ELECTRICAL CONSUMPTION IS 434 GJ, OR 0.185 GJ/m^2 YEAR WHEN THE WAREHOUSE SPACE IS INCLUDED IN THE AREA.

COMMENTS : THIS BUILDING IS AN EXAMPLE OF A BUILDING IN WHICH ONLY THE PERSONNEL AREAS ARE HEATED.

IN THE OFFICE AREA THE LARGEST SINGLE HEAT LOSS PATH IS THROUGH THE WALLS (40%). ALL OTHER PATHS ARE ABOUT EQUALLY SIGNIFICANT (ROOF 11%, WINDOWS AND DOORS 20%, SLAB ON GRADE 13%, AIR INFILTRATION 13%). THE NATURAL VENTILATION RATE IS 0.7 AIR CHANGES PER HOUR.

THE DUCT WORK FOR THE OFFICE FORCED AIR SYSTEM IS BURIED IN THE CONCRETE SLAB. TEMPERATURE MEASUREMENTS WERE TAKEN AT THE FURNACE, AND AT THE REGISTERS TO CHECK THE HEAT LOSS FROM THE DUCTWORK. THE AIR TEMPERATURE DROPPED 12% TO 34% DEPENDING ON THE LENGTH OF THE DUCT RUN. ALSO, THE FRESH AIR INTAKE DUCT'S DAMPER WAS FULLY OPEN. THIS DUCT CONNECTS TO THE RETURN AIR PLENUM, BRINGING A CONSIDERABLE AMOUNT OF COLD AIR INTO THE BUILDING.

THE ROOF DRAINS ON AN UNHEATED BUILDING MUST BE KEPT FREE OF ICE. A 2000 w, 208 VOLT HEATING CABLE AROUND AND IN THE SINGLE ROOF DRAIN IS LEFT ON ALL WINTER, CONSUMING ABOUT 5800 kwh, 20.8 GJ/YEAR ($230/YEAR). THE CABLE IS NOT THERMOSTATICALLY CONTROLLED. PRESUMABLY THERE IS NO PROBLEM WITH THE SPRINKLER SYSTEM IN THE WINTER.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-12

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : BUILT IN 1972; BY AN INVESTMENT GROUP TO THE OCCUPANT'S SPECIFICATIONS.THE OCCUPANT HAS A 25 YEAR LEASE. THIS CLOTHING MANUFACTURER USES THE BUILDING AS A STORAGE AND DISTRIBUTION CENTER.

STRUCTURE : A ONE STOREY 11,176 m^2 FLOOR AREA WAREHOUSE, OF WHICH 300 m^2 IS OFFICE SPACE. THE ROOF IS A CONVENTIONAL, INSULATED, "FLAT" ROOF WITH A BUILT UP FELT AND ASPHALT MEMBRANE. THE ROOF DECK IS SUPPORTED ON OPEN WEB STEEL JOISTS ON STEEL BEAMS AND STEEL COLUMNS. THE ROOF DECK IS 8.5 m ABOVE THE FLOOR. THE WALLS ARE INSULATED METAL CLADDING ATTACHED TO THE STEEL FRAME. THERE ARE FIVE SHIPPING DOORS ALL ON THE SOUTH WALL, AND EIGHT MAN DOORS. THERE ARE WINDOWS ONLY IN THE OFFICE AREA.

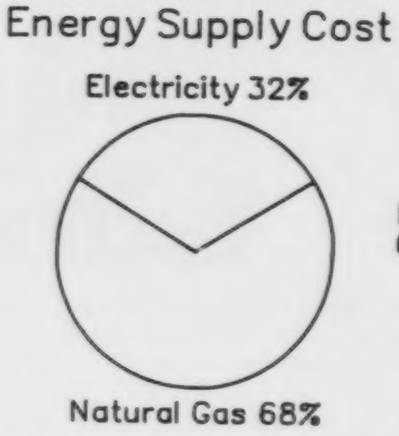
THE FOUNDATION WALLS WERE BUILT WITHOUT CRACK CONTROL JOINTS, AND RANDOM CRACKS HAVE DEVELOPED. THE CAST-IN-PLACE CONCRETE EXTERIOR WALLS OF THE OFFICE AREA HAVE CRACKED ABOVE AND BELOW MOST WINDOWS, AND THE INTERIOR FINISH SHOWS EVIDENCE OF MOISTURE PENETRATION. AGAIN, THERE ARE NO CRACK CONTROL JOINTS. THE FLOOR SLAB IN THE WAREHOUSE HAS CRACK CONTROL SAW CUTS AT EVERY SECOND COLUMN LINE.

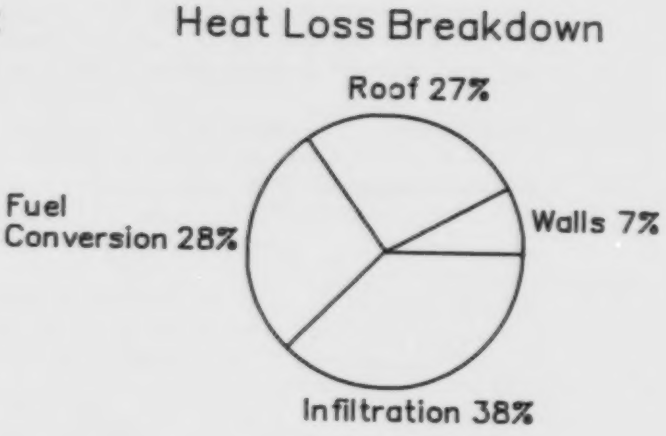
SYSTEMS : TWO LEVELS OF NATURAL GAS FIRED UNIT HEATERS SUPPLY HEATING TO THE ENTIRE WAREHOUSE. THE OFFICE AREA IS HEATED AND COOLED BY TWO ROOF MOUNTED GAS HEATER/ELECTRIC AIR CONDITIONER COMBINATION UNITS. WAREHOUSE THERMOSTATS ARE ON AUTOMATIC SET BACK (20°C DURING DAY, 10°C AT NIGHT AND WEEKENDS). THE OFFICE AREA REMAINS AT 21°C AT ALL TIMES (22°C FOR COOLING). THERE ARE SIX 1.0 m DIAMETER EXHAUST FANS ON THE ROOF THAT ARE USED ON SUMMER MORNINGS TO DRAW IN COOL AIR AND EXHAUST HOT AIR. DOWN DRAFT FANS ARE ALSO USED IN THE WAREHOUSE TO REDUCE STRATIFICATION.

75% OF LIGHTING IS PROVIDED BY FLUORESCENT FIXTURES, 25% IS EFFICIENT H.I.D. LAMPS. THE FLUORESCENT FIXTURES ARE 4 m ABOVE THE FLOOR. THE H.I.D. FIXTURES ARE LOCATED AT THE CEILING IN THE PACKING AND SHIPPING AREAS.

ENERGY : HEATING IS PROVIDED BY NATURAL GAS; COOLING, LIGHTING AND HOT WATER BY ELECTRICITY. IN 1982 THE GAS CONSUMPTION WAS 10,629 GJ; $39,901; 0.95 GJ/m^2 YEAR; 0.112 GJ/m^3 YEAR. 4% OF THE ANNUAL GAS CONSUMPTION OCCURS IN THE SUMMER; HOWEVER, THE REASON WAS NOT DETERMINED. THE ELECTRICAL CONSUMPTION WAS 1,626 GJ, $18,924, 0.15 GJ/m^2 YEAR.

Building #12





COMMENTS : THE INFILTRATION HEAT LOSS IN THIS BUILDING IS AS GREAT AS THE CONDUCTION HEAT LOSS. THE AVERAGE NATURAL VENTILATION RATE IS 0.67 AIR CHANGES PER HOUR. THE MAJOR SOURCES OF AIR LEAKAGE APPEAR TO BE THE SHIPPING DOORS, BOTH WHEN OPEN AND CLOSED, THE OPENINGS AT THE DOCK LEVELLERS, THE UNIT HEATER FLUES, AND THE INTAKE DAMPERS ON THE NORTH AND SOUTH WALLS. ONE OF THE DOCK LEVELLERS HAS BEEN TEMPORARILY SEALED WITH PACKING TAPE TO REDUCE INFILTRATION AT THE SOUTH WALL.

THIS IS THE TALLEST BUILDING IN THE VICINITY, AND IT TENDS TO BE SUBJECT TO HIGH WIND PRESSURES. THIS IS EVIDENT FROM THE WIND SCOURING AT THE NORTH WEST AND SOUTH WEST CORNERS OF THE WAREHOUSE ROOF WHERE THE GRAVEL PROTECTIVE COVER FOR THE BUILT UP MEMBRANE HAS BEEN LIFTED AWAY. PREVAILING WEST WINDS TEND TO INCREASE THE INFILTRATION AT THE WEST OFFICE ENTRANCE, AND THE WEST OFFICE ROOF/WAREHOUSE WALL JUNCTION.

TRANSMISSION OF HEAT THROUGH THE ROOF BY CONDUCTION IS THE OTHER MAJOR HEAT LOSS PATH (36%). IT HAS A LARGE SURFACE AREA AND ONLY 25 mm OF INSULATION.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-13

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OCCUPANT IN 1967. HOWEVER, THE COMPANY WAS SOLD. CURRENTLY AS A SUBSIDIARY COMPANY, ACCOUNTS ARE HANDLED FROM THE HEAD OFFICE IN WESTERN CANADA. THE BUILDING IS USED AS A DISTRIBUTION CENTER FOR HVAC EQUIPMENT AND SUPPLIES TO CONTRACTORS.

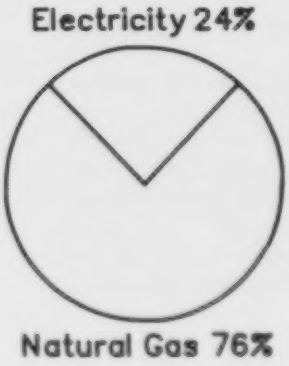
STRUCTURE : THIS IS A ONE STOREY, 937 m^2 FLOOR AREA TYPICAL FREESTANDING PRE-ENGINEERED STEEL BUILDING. THE ROOF IS PREFINISHED METAL PANELS ON STRUCTURAL STEEL PURLINS THAT REST ON THE STEEL FRAMES. THE LOW SLOPE ROOF HAS A CENTRAL RIDGE AT 5.7 m ABOVE THE SLAB, THE UNDERSIDE OF THE ROOF IS 5.1 m ABOVE THE SLAB. THE ROOF INSULATION IS FIBERGLASS BATT WITH A VINYL VAPOUR BARRIER. THE UPPER 3.1 m SECTIONS OF THE WALLS ARE INSULATED. THERE ARE TWO SHIPPING DOORS, FOUR MAN DOORS AND 30 m^2 OF SEALED DOUBLE GLAZING. THE OFFICE AREA IS 5% OF THE TOTAL FLOOR AREA.

SYSTEMS : SPACE HEATING FOR THE WAREHOUSE IS PROVIDED BY GAS UNIT HEATERS SUSPENDED FROM THE STRUCTURAL STEEL FRAMES. CEILING FANS DESTRATIFY THE HEATED AIR. THE OFFICE IS HEATED BY A NATURAL GAS FORCED AIR FURNACE AND COOLED BY A SMALL AIR CONDITIONER MOUNTED IN THE EXTERIOR WALL. ONLY THE OFFICE AREA HAS A PROGRAMMABLE THERMOSTAT FOR NIGHT AND WEEKEND SETBACK. LIGHTING IS FLUORESCENT THROUGHOUT. THERE IS ONE ELECTRIC FORKLIFT TRUCK. THE VENTILATION AND HOT WATER HEATING SYSTEMS SERVE ONLY THE WASHROOMS.

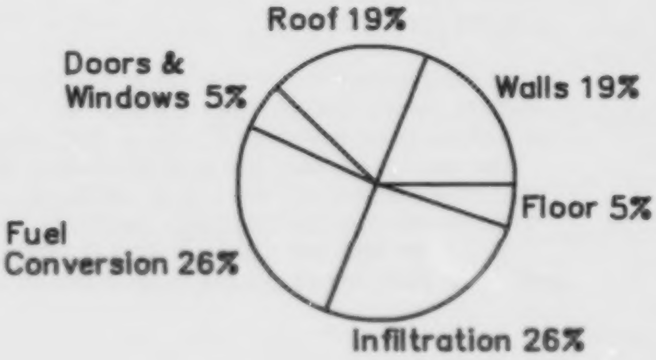
ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING. ELECTRICITY POWERS LIGHTS, COOLING, FANS, AND THE FORK LIFT VEHICLE. 1982 GAS CONSUMPTION WAS 896 GJ; \$4,295; 0.96 GJ/m^2 YEAR; 0.19 GJ/m^3 YEAR. ELECTRICAL CONSUMPTION FOR THE SAME PERIOD WAS 112 GJ; \$1,365, 0.12 GJ/m^2 YEAR.

Building #13

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : ALTHOUGH THE NATURAL INFILTRATION RATE, 0.46 AIR CHANGES PER HOUR, IS NOT HIGH IT IS THE LARGEST COMPONENT OF THE HEAT LOSS, FOLLOWED BY THE PARTIALLY INSULATED WALLS (25%), AND THE ROOF (25%). IT SHOULD BE NOTED THAT 7% OF THE TOTAL HEAT LOSS OCCURS THROUGH THE FLOOR AND FOUNDATIONS. SINCE THE BUILDING ENCLOSURE APPEARS TO BE RELATIVELY AIR TIGHT, THE MAJOR SOURCE OF AIR LEAKAGE IS PROBABLY THROUGH THE SHIPPING DOORS WHEN THEY ARE OPENED. OTHER LEAKAGE LOCATIONS ARE THE JUNCTION BETWEEN THE BRICK AND THE INSULATED STEEL CLAD WALL, THE ROOF PENETRATION AT THE OFFICE FURNACE'S FLUE, AND THE BRICK WALL CRACK CONTROL JOINTS. THE SEALANT IN THESE CONTROL JOINTS HAS HARDENED, AND IS PULLING AWAY FROM THE BRICK.

FILE NUMBER : 20601-14

BUILDING TYPE : MULTI-UNIT LIGHT INDUSTRIAL/WAREHOUSE BUILDING

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THIS COMPLEX WAS BUILT IN THREE STAGES. THE ORIGINAL BUILDING (1968) WAS USED TO MANUFACTURE, PACKAGE AND STORE COOKIES. IN 1970 THAT MANUFACTURER EXPANDED THE BUILDING FROM 1,000 m^2 TO 1,650 m^2. IN 1976, THE BUILDING WAS SOLD TO THE CURRENT OWNER, WHO ADDED 2,900 m^2, AND CONVERTED THE ENTIRE BUILDING TO A 4,550 m^2 RENTAL INDUSTRIAL MALL CONSISTING OF SIXTEEN POTENTIALLY SIMILAR RENTAL UNITS PLUS A SMALL OFFICE AREA ON THE NORTH SIDE. CURRENTLY THERE ARE FOUR TENANTS. THE MAJOR OCCUPANT RENTS THE EQUIVALENT OF NINE UNITS, OTHERS RENT 1, 2 AND 3 UNITS. TWO UNITS ARE VACANT. WHERE THE TENANT HAS MORE THAN ONE UNIT, IN GENERAL THE UNITS ARE NOT SEPARATED BY CONCRETE BLOCK PARTITIONS. MOST OF THE SPACE IS USED FOR STORAGE, LESS THAN 10% IS USED FOR OFFICE PURPOSES. THE OCCUPANTS PAY ALL UTILITY BILLS.

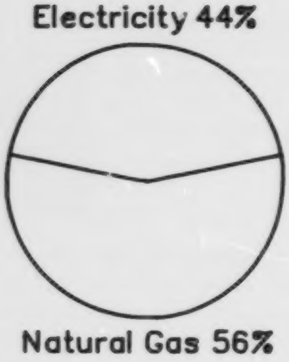
STRUCTURE : THE STRUCTURE IS A ONE STOREY 4,550 m^2 FLOOR AREA BUILDING. THE OFFICE AREAS ARE LESS THAN 10% OF THE TOTAL FLOOR AREA. THE ROOF IS A FLAT, BUILT UP MEMBRANE TYPE. THE ROOF STRUCTURE IS A STEEL DECK ON OPEN WEB STEEL JOISTS BEARING ON THE EXTERIOR CONCRETE BLOCK WALLS. THE ROOF DECK IS 5.2 ABOVE THE FLOOR. THERE ARE THREE LINES OF INTERIOR STEEL BEAMS AND COLUMNS. THE STRUCTURAL BAY SIZE IS CONSISTENT, DESPITE THE THREE STAGE CONSTRUCTION. THERE ARE NINE SHIPPING DOORS, FOUR OF WHICH HAVE DOCK LEVELLERS. THE ROOF IS INSULATED. MOST WALLS ARE UNINSULATED, EXCEPT AT THE NORTH WALL, WHERE INSULATION AND AIR SEAL RETROFIT WORK WAS DONE TO IMPROVE COMFORT AND PROTECT THE SPRINKLER SYSTEM FROM FREEZING.

SYSTEMS : THE OFFICE AREAS ARE HEATED WITH ELECTRIC BASEBOARD CONVECTORS. OTHER SPACES HAVE SUSPENDED NATURAL GAS UNIT HEATERS, EACH ON A SEPARATE THERMOSTAT. TO MINIMIZE THE NUMBER OF GAS BILLS, THE OWNER REQUESTED THAT FOUR OF THE SIXTEEN GAS METERS BE SHUT OFF. SOME OF THESE METERS HAVE BEEN REMOVED BY THE UTILITY. SMALL WINDOW AIR CONDITIONERS HAVE BEEN INSTALLED IN TWO UNITS. EXHAUST SYSTEMS ARE LIMITED TO THE BATHROOMS, AND A CHEMICAL STORAGE AREA IN ONE UNIT. LIGHTING IS FLUORESCENT THROUGHOUT. HOT WATER IS THE OCCUPANT'S RESPONSIBILITY. IF INCLUDED, IT IS ELECTRIC.

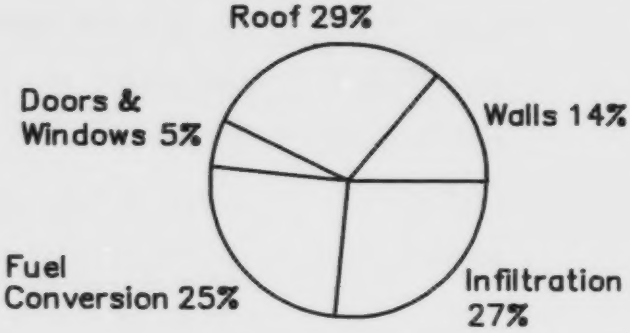
ENERGY : NATURAL GAS PROVIDES SPACE HEATING ONLY. ELECTRICITY PROVIDES OFFICE HEATING AND COOLING,INTERIOR AND EXTERIOR LIGHTING, AND MINIMAL PROCESS ENERGY. FOR VARIOUS REASONS DETAILED FUEL RECORDS WERE NOT AVAILABLE AND ONLY GROSS NATURAL GAS AND ELECTRICITY DATA WERE AVAILABLE. THE 1982 NATURAL GAS CONSUMPTION IS ESTIMATED TO BE 2,584 GJ; $12,514; 0.57 GJ/$m^2$ YEAR; 0.11 GJ/m^3 YEAR. THE ELECTRICAL SPACE HEATING CONTRIBUTION COULD NOT BE SEPARATED FROM THE TOTAL ELECTRICAL BILL. THE 1982 TOTAL ELECTRICAL CONSUMPTION IS ESTIMATED TO BE 863 GJ, $9,830, 0.19 GJ/$m^2$ YEAR.

Building #14

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE ROOF (41%), AIR INFILTRATION (35%) AND WALLS (18%) APPEAR TO BE THE MAIN CONTRIBUTORS TO THE SPACE HEATING LOAD. THE NATURAL VENTILATION RATE IS ESTIMATED TO BE 0.55 AIR CHANGES PER HOUR. THIS IS AN AVERAGE VALUE FOR THE BUILDING BASED ON THE ESTIMATED 1982 FUEL CONSUMPTION.

FUEL CONSUMPTION VARIES SIGNIFICANTLY IN SOME UNITS. UNIT 3 CONSUMES 3 TIMES THE AVERAGE; UNIT 7 AND 14 CONSUME 4 TIMES THE AVERAGE; UNIT 15 CONSUMES TWICE THE AVERAGE. THIS MAY BE A RESULT OF THERMOSTAT PROBLEMS, MANY OF WHICH ARE EITHER NOT USED, NOT CALIBRATED, NOT ADJUSTED CORRECTLY OR MISSING. SOME UNIT HEATERS APPEAR TO OPERATE CONTINUOUSLY.

PONDING WAS OBSERVED ON THE ROOF OVER UNITS 8 AND 9, AND THE ROOF IS LEAKING. ALSO OVER UNIT 9, A UNIT HEATER FLUE HAS CORRODED TO SUCH AN EXTENT THAT THE RAIN CAP HAS BLOWN OFF. WIND SCOURING AND SUBSEQUENT EXPOSURE OF THE ROOF MEMBRANE IS WORST AT THE NORTHWEST AND SOUTHWEST CORNERS WHERE 0.3 m PIERS INCREASE THE EFFECTS OF THE WIND.

THERE IS EFFLORESCENCE ON THE INTERIOR OF THE SOUTH AND EAST WALLS IN UNIT 16, MOSTLY AT THE BOTTOM OF EACH BLOCK. ALL OF THE EXTERIOR BRICK PIERS ON THE WEST SIDE DISPLAY SALT DEPOSITS (EFFLORESCENCE)..

THE CAULKING BETWEEN THE WINDOWS AND THE CONCRETE BLOCK HAS PULLED AWAY FROM THE WINDOWS, LEAVING GAPS IN MANY LOCATIONS.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-15

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY : THE MAIN BUILDING WAS BUILT IN 1968 BY THE OWNER/OCCUPANT PRIMARILY AS A DISTRIBUTION CENTER FOR BOOKS WITH ASSOCIATED OFFICE SPACE. A MAJOR EXPANSION TO THE WAREHOUSE AREA OCCURRED IN 1972, SOME OF THIS SPACE IS RENTED TO A WHOLESALE FLORIST. THE BUILDING HAS RECENTLY BEEN SOLD AND WILL BE USED AS A DISTRIBUTION CENTER FOR ELECTRONIC EQUIPMENT.

STRUCTURE : A ONE STOREY BUILDING EXCEPT FOR 217 m^2 OF OFFICE ON A MEZZANINE FLOOR. GROUND FLOOR OFFICES TAKE UP 20% OF THE GROUND FLOOR AREA. THE 3241 m^2 GROUND FLOOR AREA INCLUDES THE SPACE LEASED TO THE FLORIST. THE ROOF DECK IS 5.5 m ABOVE THE FLOOR IN THE MAIN BUILDING, 4.9m IN THE ADDITION. THE ROOF IS A FLAT BUILT-UP MEMBRANE ON RIGID INSULTION (39 mm ASSUMED). THE STEEL DECK IS SUPPORTED ON OPEN WEB STEEL JOISTS ON THE STEEL STRUCTURE. THE EXTERIOR BRICK AND BLOCK WALLS ARE LOADBEARING. THE INTERIOR STRUCTURE IS STEEL BEAMS AND COLUMNS.

THE SHIPPING/RECEIVING AREA WITH TWO SHIPPING DOORS IS ISOLATED BY MEANS OF A CONCRETE BLOCK WALL AND PLASTIC CURTAINS, FROM THE REST OF THE BUILDING. THERE ARE FOUR SHIPPING DOORS, TWO IN THE FLORIST AREA, TWO IN THE WAREHOUSE AREA (ONE WITH A DOCK LEVELLER).

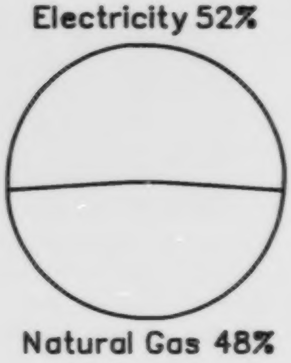
THE SOUTH GLAZING HAS BEEN RETROFITTED WITH A REFLECTIVE FILM TO MINIMIZE FADING OF STORED BOOKS, AND REDUCE SUMMER HEAT GAIN. THE ORIGINAL SINGLE GLAZED WINDOWS IN THE OFFICE AREA WERE RETROFITTED WITH A SECOND SASH AND GLAZING.

SYSTEMS : THE WAREHOUSE IS HEATED BY SUSPENDED NATURAL GAS UNIT HEATERS. THE OFFICES ARE HEATED/COOLED BY ROOF MOUNTED COMBINATION UNITS. THE HEATING SECTION IS GAS FIRED. THE OFFICES ON THE MEZZANINE FLOOR ARE HEATED BY ELECTRIC BASEBOARD HEATERS, AND COOLED BY WINDOW AIR CONDITIONERS. LIGHTING IS FLUORESCENT THROUGHOUT.

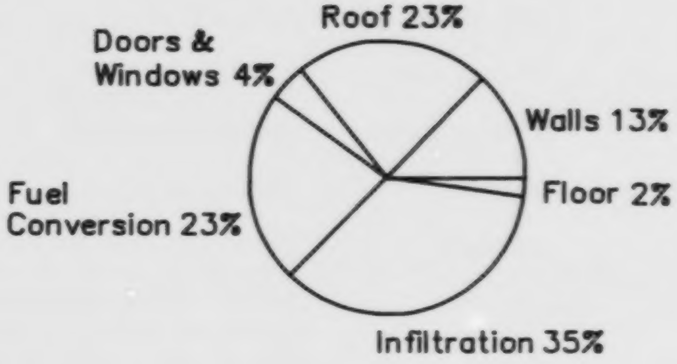
ENERGY : NATURAL GAS IS USED FOR SPACE HEATING ONLY. ELECTRICITY PROVIDES SOME HEATING FOR MEZZANINE OFFICES AND ALL COOLING AND LIGHTING. 1981 FUEL CONSUMPTION WAS USED AS A REFERENCE FOR OUR CALCULATIONS. IN 1981 THE SPACE HEATING NATURAL GAS CONSUMPTION WAS 3,298 GJ, 1.02 GJ/m^2, 0.198 GJ/m^3, $11,581. THE 1981 ELECTRICAL CONSUMPTION WAS 1,246 GJ, 0.38 GJ/m^2, $12,634. THE TOTAL HEATING AND ELECTRICAL ENERGY CONSUMPTION WAS 4,544 GJ, 1.40 GJ/m^2 YEAR. THE COST OF ELECTRICAL ENERGY WAS GREATER THAN THAT FOR GAS.

Building #15

Energy Supply Cost



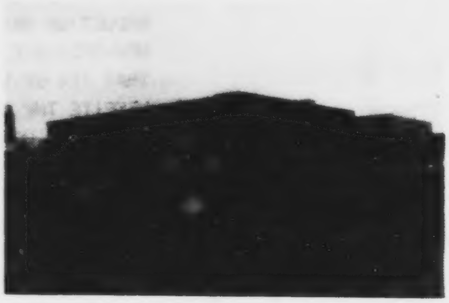
Heat Loss Breakdown



COMMENTS : THE ANALYSIS INDICATES THAT AIR LEAKAGE (47%), THE ROOF (29%), AND THE WALLS (15%) ARE THE MAJOR CONTRIBUTORS TO HEAT LOSS. CONSIDERING THE MAGNITUDE OF THE ELECTRICAL GAINS THIS IS A RELATIVELY EXPENSIVE BUILDING TO HEAT. SIMILARLY ELECTRICAL CONSUMPTION SEEMS TO BE RELATIVELY HIGH FOR THIS TYPE OF BUILDING.

THE MAIN ROOF IS FULLY PONDED AND DESPITE THE ROOF DRAINS, IT SEEMS TO STAY THIS WAY. LEAKAGE , HOWEVER, DOES NOT SEEM TO BE A PROBLEM. THE ROOF FLASHING AT THE JUNCTION OF THE ORIGINAL BUILDING AND THE ADDITION NEEDS REPAIR AND RECAULKING.

TWO SHIPPING DOORS HAVE TRAILER SEALS. HOWEVER, THE PAVING SLOPES TOWARDS THE BUILDING, WHICH TENDS TO PREVENT A GOOD SEAL AT THE BOTTOM OF THE TRAILER.



FILE NUMBER : 20601-16

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT TO THE OWNER/OCCUPANT'S SPECIFICATIONS IN 1982. THE MAIN FLOOR AREA (85%) IS DEVOTED TO THE ASSEMBLY AND STORAGE OF WOOD WINDOWS OR ALUMINUM DOORS. THE REMAINING 15% IS OFFICE/SHOWROOM SPACE. THE BUILDING IS OCCUPIED FOR ONE 8 HOUR SHIFT PER DAY.

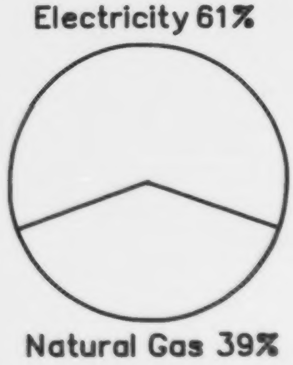
STRUCTURE : THE BUILDING IS ONE STOREY, WITH A STORAGE MEZZANINE OVER THE OFFICE AREA. THE GROUND FLOOR AREA IS 724 m^2. THE ROOF IS 'FLAT' WITH A BUILT UP ROOFING MEMBRANE AND IT IS 5.1 m FROM THE FLOOR TO THE UNDER SIDE OF THE STEEL ROOF DECK. STEEL BEAMS ARE SUPPORTED ON STEEL COLUMNS, HOWEVER, THE STEEL JOISTS BEAR ON THE CONCRETE BLOCK WALLS. THE CONCRETE BLOCKS ARE DESIGNED TO ACCEPT AN INSULATING FOAM INSERT. THERE IS 75 mm OF RIGID INSULATION IN THE ROOF, AND INSULATION AT THE OFFICE AREA FOUNDATION WALL. ONLY ONE OF THE THREE SHIPPING DOORS IS USED. OF THE TOTAL 27 m^2 OF GLASS, 15.8 m^2 IS IN THE OFFICE AREA, FACING NORTH WEST.

SYSTEMS : THE PRODUCTION/STORAGE AREA IS HEATED BY FIVE SEPARATELY CONTROLLED GAS FIRED RADIANT HEATERS SUSPENDED BELOW THE STEEL JOISTS. THE OFFICE/SHOWROOM AREA IS HEATED AND COOLED BY A GAS FIRED FORCED AIR UNIT ON THE ROOF. THE INTERIOR LIGHTS ARE FLUORESCENT. THE EXTERIOR LIGHTS ARE INCANDESCENT SPOT LIGHTS. THE PROCESS EQUIPMENT IS FAIRLY LIGHT. IT INCLUDES AN AIR COMPRESSOR, DRILLS, SAWS, AND METAL CUTTERS.

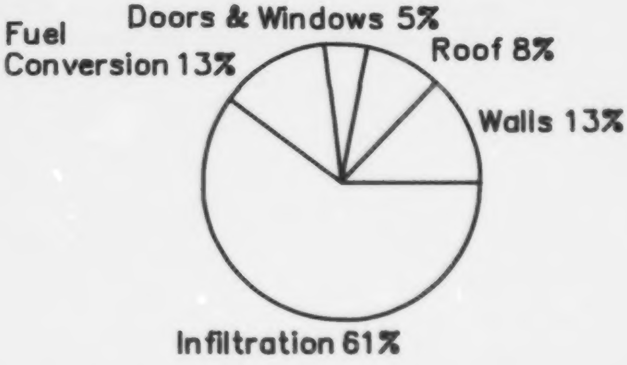
ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING. ELECTRICITY POWERS ALL LIGHTING AND EQUIPMENT, AND PROVIDES THE HOT WATER. THE 1982 SPACE HEATING ENERGY IS 508 GJ, \$2570, 0.70 GJ/m^2/YEAR, 0.14 GJ/m^3/YEAR. THE 1982 ELECTRICAL CONSUMPTION IS 335 GJ IN, \$4081, 0.46 GJ/m^2 YEAR. HOWEVER, 1982 WAS NOT A TYPICAL YEAR. THE BUILDING WAS FINISHED AND OCCUPIED IN JANUARY.

Building #16

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : CONDUCTION HEAT LOSS HAS BEEN REDUCED BY ROOF AND WALL INSULATION, AND INSULATION BELOW GRADE AT THE OFFICE AREA. HOWEVER, INFILTRATION REDUCTION HAS NOT BEEN AS EFFECTIVE. EVEN THOUGH ALL WINDOWS ARE NON-OPERABLE, AND THE MAN DOORS ARE WEATHERSTRIPPED, THE ANALYSIS SHOWS THAT 71% OF THE REMAINING HEAT LOSS IS ATTRIBUTABLE TO AIR INFILTRATION, DESPITE THE ATTEMPTS TO SEAL THE STEEL DECK CHANNELS WHERE THE WALL MEETS THE ROOF, USING FIBERGLASS BATTS. THE HIGH AIR CHANGE RATE, 1.81 AIR CHANGES PER HOUR, MAY BE ATTRIBUTED TO THE INDOOR LOADING DOCK WHICH IS NOT SEPARATED FROM THE HEATED SPACE, THE 25 mm CRACKS AT THE TOP OF EACH SHIPPING DOOR, THE FLUTES AT THE STEEL DECK PERIMETER, AND OTHER CRACKS AROUND DOORS.

THE COMPUTER MODEL USES THE MANUFACTURER'S TESTED THERMAL RESISTANCE OF THE BLOCK (RSI 1.09). THE TEMPERATURE GRADIENT ACROSS SIX BLOCKS WAS CHECKED, BUT THE RESULTS WERE TOO SCATTERED TO RELIABLY REPORT ON THE IN-USE PERFORMANCE.

THE COST OF ELECTRICITY IS ALMOST DOUBLE THAT OF THE NATURAL GAS FOR SPACE HEATING. CONSERVATION EFFORTS DIRECTED AT LIGHTING WILL HAVE THE MOST POTENTIAL. THE WINDOWS PROVIDE AMPLE LIGHTING AT THE NORTH AND SOUTH AREAS (70 FOOT CANDLES ON AN OVERCAST DAY). IT WAS ALSO NOTED THAT THE LIGHT FIXTURE DISTRIBUTION IS A SIMPLE FIVE ROW SYSTEM THAT DOES NOT LOCATE THE LIGHT OPTIMALLY TO ILLUMINATE WORKING AREAS.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-17

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT TO THE OWNER/OCCUPANT'S SPECIFICATIONS IN 1975 AS A WAREHOUSE AND DISTRIBUTION CENTER FOR TWO COMPANIES. THERE ARE TWO LEVELS OF OFFICES IN THE SOUTHWEST CORNER. THE STORED MATERIAL INCLUDES STOCK FOR RETAIL HARDWARE STORES, AND VARIOUS PHARMACEUTICALS. THE PERSONNEL WORKING IN THE WAREHOUSE ARE UNIONIZED.

STRUCTURE : THE WAREHOUSE AREAS ARE ONE STOREY 9.8 m HIGH (SLAB TO ROOF DECK) WITH A TOTAL FLOOR AREA OF 38,854 m^2. THE OFFICE FLOOR AREA IS 2,205 m^2 (6% OF THE TOTAL FLOOR AREA). THE ROOF IS INSULATED. THE ROOF IS FLAT WITH A BUILT UP MEMBRANE. THE ROOF STRUCTURE IS STEEL JOISTS ON STEEL BEAMS AND COLUMNS. THE UNINSULATED PRECAST CONCRETE EXTERIOR WALLS ARE NON LOADBEARING.

THE SHIPPING/RECEIVING AREAS FOR SOME THIRTY TRUCK TRAILERS ARE ALL INSIDE THE BUILDING. THE LARGE ENTRANCE AND EXIT DOORS ARE OFTEN OPEN DURING WORKING HOURS. THERE ARE OPENABLE WINDOWS HIGH IN THE WALLS, AND FIXED WINDOWS FOR THE OFFICES. THERE IS ONE PLASTIC SKYLIGHT IN EACH WAREHOUSE BAY. THEY ARE INTENDED TO MELT IN CASE OF FIRE AND PURGE SMOKE.

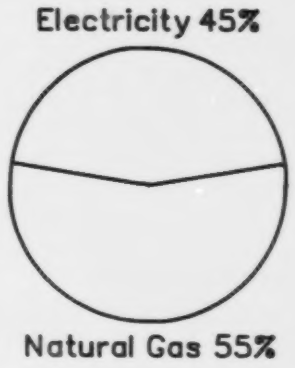
SYSTEMS : THE WAREHOUSE IS HEATED BY FOUR LARGE BOILERS THAT SUPPLY HOT WATER TO FAN COIL UNITS AROUND THE BUILDING. THERE IS NIGHT SETBACK IN THE WAREHOUSE AREA ONLY. THE OFFICES ARE HEATED AND COOLED BY ROOF MOUNTED FORCED AIR UNITS. THE COMPUTER ROOMS HAVE THEIR OWN COOLING SYSTEMS. THERE IS A SMALL REFRIGERATED STORAGE ROOM WITH ITS OWN CHILLER. THERE ARE SEVEN 1 m DIAMETER EXHAUST FANS AT FLOOR LEVEL IN THE SHIPPING AREAS. THEY OPERATE CONTINUALLY DURING WORKING HOURS.

INTERIOR LIGHTING IS FLUORESCENT, WITH SOME NATURAL LIGHT FROM SKYLIGHTS AND WINDOWS. EXTERIOR LIGHTING IS H.I.D. FIXTURES ON THE BUILDING, OR ON LAMP STANDARDS. THE FORK LIFTS ARE RECHARGEABLE ELECTRIC VEHICLES.

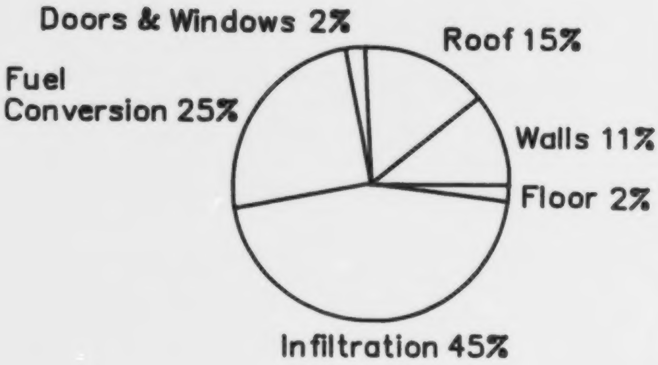
ENERGY : NATURAL GAS ONLY PROVIDES SPACE HEATING. ELECTRICITY IS USED FOR COOLING, LIGHTING, EXHAUST EQUIPMENT AND THE FORK LIFT TRUCKS. THE 1982 NATURAL GAS/SPACE HEATING CONSUMPTION WAS 44,411 GJ, $123,567, 1.14 GJ.$m^2$, 0.118 GJ/$m^3$ YEAR. THE 1982 ELECTRICAL CONSUMPTION WAS 11,240, $99,588, 0.29 GJ.$m^2$ YEAR.

Building #17

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE LARGEST CONTRIBUTOR TO THE COST OF SPACE HEATING IS THE AIR LEAKAGE RATE OF 0.65 AIR CHANGES PER HOUR. THIS IS AN AVERAGE, COMBINED RATE COMPOSED OF MECHANICAL EXHAUST SYSTEMS AND NATURAL VENTILATION. IT ACCOUNTS FOR 60% OF THE HEATING LOAD. THE MECHANICAL EXHAUST CONTRIBUTION TO THE SPACE HEATING LOAD IS SMALL IN COMPARISON TO THAT DUE TO THE NATURAL VENTILATION. THE WALLS AND ROOF ARE QUITE AIR TIGHT, AND THE INFILTRATION IS CONCENTRATED AT THE SHIPPING AREAS, WHERE THE TRUCKS ARE CONSTANTLY MOVING THROUGH THE LARGE SHIPPING DOORS. ONE SHIPPING/RECEIVING AREA IS ON THE WEST SIDE OF THE BUILDING, WHILE THE OTHER IS ON THE SOUTH SIDE. THESE AREAS ARE OFTEN UNCOMFORTABLY COLD DURING HIGH WIND CONDITIONS. UNION RULES REQUIRE THAT THE TEMPERATURE BE ABOVE 18°C WHEN THE BUILDING IS OCCUPIED. THIS MAY CONTRIBUTE TO THE HIGHER THAN AVERAGE SPACE HEATING ENERGY CONSUMPTION. THIS INDEX IS 35% GREATER THAN THE AVERAGE OF OTHER SIMILAR BUILDINGS IN OUR SURVEY.

THE ROOF (20%) AND THE WALLS (15%) ARE THE OTHER MAIN COMPONENTS OF THE HEAT LOSS. THE ROOF HAS A LARGE SURFACE AREA, AND MINIMAL INSULATION. THE WALLS HAVE NO INSULATION.

THE ROOF IS PERFORMING WELL, HOWEVER, WIND SCOURING HAS EXPOSED THE MEMBRANE AT THE NORTH WEST AND SOUTH WEST CORNERS. THE ASPHALT AND FELTS ARE DETERIORATING THERE. ALSO, WHERE NEW SUPPORTS FOR THE NATURAL GAS PIPE WERE INSTALLED, THE STONE WAS NOT REPLACED OVER SEVERAL REPAIRED AREAS OF MEMBRANE. THESE AREAS HAVE NOT DETERIORATED SEVERELY SINCE THE WORK WAS DONE RECENTLY. A DARK COLOURED ALGAE COVERS MUCH OF THE ROOF SURFACE. THIS ALGAE FLOATS AND CLOGS DRAINS LEADING TO PONDING OVER LARGE AREAS OF THE ROOF. MAINTENANCE PERSONNEL CLEAN THE DRAINS AFTER EACH STORM.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-18

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY: : THE BUILDING IS OWNED BY A MAJOR WAREHOUSING FIRM. IT IS LEASED TO A SEPARATE ORGANIZATION, AND USED AS A DISTRIBUTION CENTRE FOR BOTTLED GOODS. OPERATING HOURS ARE: JANUARY TO JUNE, 7 AM TO 4 PM; JUNE TO DECEMBER, 7 AM TO 10.30 PM. THE BUILDING is OPEN 24 HOURS A DAY BEFORE MAJOR PUBLIC HOLIDAYS. THE PERSONNEL WORKING IN THE WAREHOUSE ARE UNIONIZED.

STRUCTURE : THIS IS A LARGE BUILDING BUILT IN 1968. THE FLOOR AREA IS 29,484 m^2, MOST OF WHICH IS WAREHOUSE SPACE. LESS THAN 2% IS OFFICE. THE FLAT ROOF IS INSULATED AND HAS A BUILT UP MEMBRANE. THE STEEL ROOF DECK (7.9 m ABOVE SLAB) IS SUPPORTED ON OPEN WEB STEEL JOISTS ON STEEL BEAMS AND COLUMNS. THE NON-LOADBEARING PRECAST CONCRETE EXTERIOR WALL PANELS ARE SUPPORTED BY THAT STEEL SYSTEM. THE EAST WALL IS CONCRETE BLOCK. NONE OF THE WALLS ARE INSULATED.

THE SHIPPING AREAS ARE FULLY ENCLOSED FROM THE OUTSIDE ENVIRONMENT. THEY ARE NOT ISOLATED FROM THE WAREHOUSE. SINCE TRUCK TRAILERS ARE DRIVEN INTO THE BUILDING, THE SHIPPING AREA MUST BE VENTILATED TO REMOVE THE EXHAUST.

SYSTEMS : TWO LARGE BOILERS PROVIDE ALL SPACE HEATING. THE TEMPERATURE IS AUTOMATICALLY SETBACK WHEN THE BUILDING IS UNOCCUPIED. THE BOILERS ALWAYS RUN ON NATURAL GAS, EVEN THOUGH THEY HAVE RESERVE OIL BURNERS AS WELL. A LOWER NATURAL GAS COST HAS BEEN NEGOTIATED SINCE THE UTILITY CAN INTERRUPT SERVICE. AT SHORT NOTICE PUMPS CIRCULATE THE WATER TO FAN COIL UNITS AT THE ROOF LEVEL THROUGHOUT THE WAREHOUSE, AND TO RADIATORS IN THE OFFICES. THE SYSTEM IS FIFTEEN YEARS OLD, AND IS THE SUBJECT OF CONSTANT REPAIR. THE PIPES ARE REPORTED TO BE FULL OF CALCIUM DEPOSITS.WINDOW AIR CONDITIONERS ARE THE ONLY COOLING SYSTEMS.

ALL LIGHTING IS FLUORESCENT WITH 3 PHASE, 347 VOLT 80 WATT BULBS. MAINTENANCE COSTS ARE REPORTED TO BE HIGHER THAN FOR STANDARD SYSTEMS SINCE THE BULBS AND ESPECIALLY THE BALLASTS ARE MORE EXPENSIVE. THERE ARE DESTRATIFICATION FANS AROUND THE PERIMETER OF THE WAREHOUSE. THERE ARE FIVE 1.0 m DIAMETER EXHAUST FANS AT THE SHIPPING AREA TO PURGE TRUCK EXHAUST FUMES DURING OPERATING HOURS.

ENERGY : NATURAL GAS ONLY PROVIDES SPACE HEATING. THE 1981-82 CONSUMPTION IS CALCULATED BASED ON THE MONTHLY COSTS AND THE RATE STRUCTURE. IT IS 46,000 GJ, $165,407, 1.6 GJ/m^2 YEAR, 0.197 GJ/m^3 YEAR. THE MAJOR ELECTRICAL CONSUMPTION IS FLUORESCENT LIGHTING. OTHER LOADS ARE FANS, PUMPS, FORK LIFTS, AND AIR CONDITIONING. ELECTRICAL CONSUMPTION WAS NOT
]

AVAILABLE FOR THIS BUILDING. BASED ON A SIMILAR BUILDING, THE TOTAL ELECTRICAL CONSUMPTION IS ESTIMATED TO BE 7,740 GJ, $112,270, 0.26 GJ/$m^2$ YEAR. THIS WOULD BE THE EQUIVALENT OF $112,227 AT 1982 RATES.

COMMENTS : THE NATURAL VENTILATION RATE OF 0.94 AIR CHANGES PER HOUR IS HIGHER THAN USUAL FOR A BUILDING WITH SUCH AIRTIGHT WALL AND ROOF CONSTRUCTIONS. IT MAY BE DUE TO THE SHIPPING DOCK ARRANGEMENT. DURING PEAK PERIODS, THE 4.3 m x 4.3 m DOORS MAY BE OPEN 24 HOURS PER DAY. ALSO, BRINGING COLD TRAILERS INTO THE BUILDING WOULD INCREASE THE HEATING LOAD.

AFTER AIR LEAKAGE (60%), THE MOST SIGNIFICANT AREA OF HEAT LOSS IS THE ROOF (19%), FOLLOWED BY THE UNINSULATED WALLS (15%).

MAINTENANCE PROBLEMS OCCUR WITH THE SHIPPING DOORS AND THE DOCK LEVELLERS. THE BOTTOM PANELS ON THE LARGE SHIPPING DOORS ARE DAMAGED DUE TO CONSTANT USE. THE HINGES AND HYDRAULICS ON THE DOCK LEVELLERS BREAK CONSTANTLY, ELIMINATING ONE TRUCK LOCATION, AND LIMITING PRODUCTION. MANUAL EQUIPMENT WITHOUT HYDRAULICS IS THE TYPE PREFERRED BY THEIR MAINTENANCE MANAGER.

THE FIRE MARSHALL WILL ONLY PERMIT ITEMS TO BE STORED THREE SKIDS HIGH IN THIS BUILDING. THIS MEANS THAT THE UPPER 3m OF THE INTERNAL VOLUME CANNOT BE USED. HOWEVER, IT MUST BE HEATED.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-19A

BUILDING TYPE : PRODUCTION SPACE FOR LIGHT INDUSTRIAL BUILDING

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THIS SECTION OF THE BUILDING HAS BEEN EXPANDED IN STAGES, WITH THE MOST RECENT ADDITION IN 1978. THERE ARE FOUR MAJOR USES: PARTS WAREHOUSE/SALES, ELECTRIC MOTOR REBUILDING SHOP, SHEET METAL BENDING SHOP AND AN ELECTRIC CONTROL PANELS SHOP IN THE NEWEST SECTION. SOME 30 PEOPLE WORK IN THESE AREAS, USUALLY ONE SHIFT PER DAY.

STRUCTURE : THE PRODUCTION AREAS ARE HIGH (5.8 m) CEILINGED, TOTALING 3,594 m^2 IN FLOOR AREA. THE STRUCTURE IS STEEL JOISTS ON STEEL BEAMS AND COLUMNS. THE NEWEST SECTION HAS INSULATED STEEL CLAD WALLS, WHEREAS ALL OTHER WALLS ARE NON-LOAD BEARING CONCRETE BLOCK. THE OFFICE AREA IS NORTH OF THE PRODUCTION SPACE.

SYSTEMS : UNIT HEATERS SUSPENDED BELOW THE CEILING PROVIDE ALL SPACE HEATING. THERE IS AN AUTOMATIC SETBACK SYSTEM FOR THE PRODUCTION/WAREHOUSE AREAS ONLY. THERE IS NO COOLING IN THE PRODUCTION SPACES. HOWEVER, THERE ARE SEVERAL LARGE EXHAUST SYSTEMS. THE SHEET METAL SHOP EXHAUST RATE WAS MEASURED AT 5,300 1/s. THE MAKE-UP AIR UNIT'S FLOW RATE WAS NOT MEASURED. THE MAKE-UP AIR UNIT IN THE MOTOR SHOP IS ALSO A DIRECT FIRED NATURAL GAS UNIT, BRINGING IN 4,420 1/s. THERE ARE MANY SMALL EXHAUSTERS FOR VARIOUS WORK STATIONS.

THE LIGHTING IS FLUORESCENT, EXCEPT IN THE NEWEST ADDITION, WHERE H.I.D. FIXTURES HAVE BEEN INSTALLED. THERE IS ONE ELECTRIC HOT WATER TANK.

ENERGY : NATURAL GAS PROVIDES SPACE HEATING AND HEAT FOR A PROCESS OVEN. THERE IS ONLY ONE GAS AND ONE ELECTRIC MOTOR FOR TWO BUILDINGS. THIS ARRANGEMENT MINIMIZES THE COST OF THE ENERGY BY KEEPING THE CONSUMPTION AT THE INEXPENSIVE END OF THE RATE STRUCTURE, BUT MAKES INTERPRETATION OF CONSUMPTION DIFFICULT. IN TERMS OF THE ENTIRE COMPLEX, THE TOTAL NATURAL GAS CONSUMPTION OVER THE 1981/82 HEATING SEASON WAS 5,970 GJ, $25,566. BASED ON THE SUMMER CONSUMPTION 8% OF THAT IS PROCESS CONSUMPTION. THEREFORE THE SPACE HEAT ENERGY CONSUMPTION WAS 5,490 GJ, $23,510, 1.05 GJ/$m^2$ YEAR; 0.20 GJ/m^3 YEAR. THE ELECTRICAL CONSUMPTION WAS 3,640 GJ, $35,786 ($32,280 ENERGY, $3,506 DEMAND) 0.69 GJ/$m^2$ YEAR. ELECTRICITY PROVIDES ALL LIGHTING, AND OTHER PROCESS ENERGY.

COMMENTS : ELECTRICAL CONSUMPTION IS A GREATER EXPENSE THAN SPACE HEAT ENERGY. HOWEVER, BOTH PER UNIT AREA ENERGY CONSUMPTION INDICES ARE RELATIVELY HIGH, SUGGESTING THAT THERE IS CONSERVATION POTENTIAL IN BOTH AREAS. THE ATTACHED HEAT LOAD BREAKDOWN IS BASED ON AN ESTIMATED 1.75 AIR CHANGES PER

HOUR, A COMBINED NATURAL AND MECHANICAL VENTILATION RATE. OTHER ESTIMATED VALUES ARE THE ROOF INSULATION AND THE INTERNAL HEAT GAIN, BOTH FROM ELECTRIC EQUIPMENT AND THE NATURAL GAS BURNING OVENS. THE PREDICTED GAS CONSUMPTION FOR BOTH BUILDINGS IS 23 % LESS THAN THE 1981/82 ACTUAL CONSUMPTION. THE REASON FOR THIS CANNOT BE DETERMINED WITHOUT ANALYSIS WHICH IS BEYOND THE SCOPE OF OUR SURVEY. HOWEVER, THIS REPORT MAY BE OF VALUE TO HELP CLARIFY PRIORITIES IF CONSERVATION/COST REDUCTION MEASURES ARE BEING CONSIDERED. IN THIS SCENARIO, THE MOST SIGNIFICANT TYPE OF HEAT LOSS IS THE AIR LEAKAGE RATE OF 1.75 AIR CHANGES PER HOUR, WHICH ACCOUNTS FOR 67%. THE ROOF (15%) AND WALLS (14%) ARE MUCH LESS IMPORTANT.

THE EXHAUST EQUIPMENT IS ALWAYS ON WHEN THE BUILDING IS OCCUPIED, RATHER THAN BEING SWITCHED TO PROVIDE SPECIFIC AIR QUALITY REQUIREMENTS. NONE OF THE HEAT IN THE EXHAUST AIR IS RECOVERED BY THE MAKE-UP AIR UNITS. THE MAKE-UP AIR UNITS HAVE A VARIABLE FIRING RATE. SINCE THEY ARE DIRECT FIRED UNITS, ALL OF THE POTENTIAL HEAT IN THE NATURAL GAS IS DELIVERED TO THE BUILDING. APART FROM A LOOSE ACCESS PANEL ON A ROOFTOP EXHAUST UNIT, ALL EQUIPMENT APPEARS TO BE IN GOOD OPERATING CONDITION.

ONE UNIT HEATER WAS TESTED. THE FIRST HEAT EXCHANGER CORE SHOWED A CO_2 CONCENTRATION OF 7 PPM, EXIT TEMPERATURE OF 500°F, 75.75% EFFICIENCY, THE SECOND CORE SHOWED 8 PPM, 475°F, 77.50% RESPECTIVELY.

THE LIGHTS OVER THE WORK STATIONS ARE JUST BELOW THE ROOF JOISTS PROVIDING BRIGHT GENERAL LIGHTING RATHER THAN TASK LIGHTING.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-198

BUILDING TYPE : OFFICE AREA FOR LIGHT INDUSTRIAL BUILDING

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE BUILDING IS OWNED BY THE OCCUPANT. THE BUILDING HAS BEEN BUILT IN MANY STAGES. THE OFFICE AREA WAS CONSTRUCTED SOME FIFTEEN YEARS AGO, AND THIS PART OF THE BUILDING HOUSES ALL ADMINISTRATIVE AND ENGINEERING PERSONNEL. THE OFFICES ARE NEXT TO THE PRODUCTION AREAS.

STRUCTURE : THE OFFICE AREA IS MOSTLY SINGLE STOREY, BUT INCLUDES A MEZZANINE AREA. OFFICE SPACE COMPRISES 24% OF THE GROUND FLOOR AREA . THE OFFICE ROOF AREA IS 1,127 m^2, THE WALLS ARE 4.0 m HIGH. THE EXTERIOR WALLS ARE PRECAST CONCRETE WITH INSULATION AND DRYWALL ON THE INTERIOR. THE INTERIOR STRUCTURE IS STEEL BEAMS AND COLUMNS. THE FLAT ROOF STRUCTURE IS A STEEL DECK ON OPEN WEB STEEL JOISTS. THE WATERPROOFING IS A BUILT-UP MEMBRANE ON RIGID INSULATION.

SYSTEMS : THE MAIN OFFICE IS HEATED AND COOLED BY THREE ROOF MOUNTED UNITS. THE MEZZANINE IS HEATED AND COOLED BY THREE MORE UNITS. THE COMPUTER ROOM HAS ITS OWN COOLING UNIT. ALL HEATING SYSTEMS USE NATURAL GAS, ALL COOLING IS ELECTRIC. SOME OF THE COOLING UNITS HAVE AN "ECONOMIZER" FUNCTION THAT DRAWS IN OUTSIDE AIR FOR FIRST STAGE COOLING. THERE ARE NO AUTOMATIC SETBACK CONTROLS FOR THE OFFICE AREA. THERE ARE FOUR EXHAUST UNITS.

ENERGY : ALL SPACE HEATING IS PROVIDED BY NATURAL GAS. THE MAJOR ELECTRICAL LOAD IS LIGHTING. THIS SECTION OF THE BUILDING DOES NOT HAVE ITS OWN GAS OR ELECTRIC METER, AND THEREFORE, THE PREDICTED SPACE HEAT ENERGY CONSUMPTION CANNOT BE CHECKED AGAINST ACTUAL CONSUMPTION. THERE IS ONLY ONE ELECTRIC AND ONE NATURAL GAS BILL FOR EACH BILLING PERIOD.

COMMENTS : OUR STANDARDIZED AUDIT AND ANALYSIS PROCEDURE IS NOT ADEQUATE FOR THE SITUATION PREVAILING AT THIS THREE BUILDING COMPLEX. WITHOUT REASONABLE FUEL RECORDS AND WITHOUT CRUCIAL THERMAL PROPERTIES ACCURATE ANALYSIS IS IMPOSSIBLE. IN THIS CASE, MANY VARIABLES ARE UNCERTAIN; THE ROOF INSULATION, THE WALL INSULATION, AND THE CONTRIBUTION OF INTERNAL GAINS, AS WELL AS THE AIR CHANGE RATE.

WE HAVE PROVIDED YOU WITH A PRINTOUT OF AN ANALYSIS THAT WE HAVE RUN. NUMEROUS ASSUMPTIONS HAVE HAD TO BE MADE. HOWEVER, THE RESULTS ARE USEFUL IN PROVIDING AN OVERVIEW OF THE HEAT LOSS. INFILTRATION (52%) IS THE LARGEST LOAD FOLLOWED BY THE ROOF (27%), THE SLAB (8%) AND THE WALLS (8%), IF THE AIR CHANGE RATE IS 1.0 AIR CHANGES PER HOUR.

THE OFFICE AREA IS AIR CONDITIONED. WHEN POSSIBLE, THE EQUIPMENT USES OUTSIDE AIR FOR COOLING. THE ELECTRICAL CONSUMPTION, THOUGH QUITE CONSISTANT SHOWS SMALL ENERGY AND POWER PEAKS IN THE LATE WINTER AND LATE SUMMER MONTHS, SUGGESTING A LARGE AND CONTINUING LIGHTING LOAD, AND ONLY MODERATE VARIATIONS DUE TO THE WEATHER. THE SIGNIFICANCE OF THE AIR CONDITIONING LOAD CANNOT BE DEDUCED FROM THE AVAILABLE DATA.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-20

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THIS BUILDING IS OVER TWENTY YEARS OLD. IT WAS RECENTLY PURCHASED SOLELY FOR USE IN WELDING LARGE PIPES. A SMALL PARTITIONED ROOM, NOT THERMALLY SEPARATE FROM THE PRODUCTION SPACE, SERVES AS AN OFFICE. ADMINISTRATION AND SHOP DRAWINGS ARE DONE IN ANOTHER BUILDING.

STRUCTURE : THE BUILDING IS ONE STOREY, 525 m^2 FLOOR AREA. THE INSULATED 'FLAT' ROOF HAS A BUILT UP ROOF MEMBRANE. THE WALLS ARE UNINSULATED CONCRETE BLOCK, 3.2 m HIGH, SUPPORTING STEEL JOISTS. THERE IS ONE LINE OF INTERIOR STEEL BEAMS ON STEEL COLUMNS. LARGE, SINGLE GLAZED WINDOW AREAS ON THE NORTH, EAST AND SOUTH PROVIDE GOOD DAYLIGHTING. THERE ARE TWO SHIPPING DOORS ON THE SOUTH SIDE.

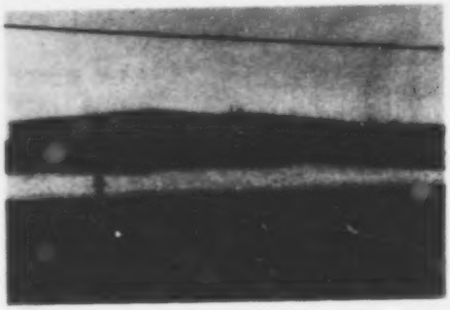
SYSTEMS : FOUR FLOOR MOUNTED GAS FIRED FURNACES HEAT THE BUILDING. THE SPACE TEMPERATURE IS AUTOMATICALLY SET BACK AT NIGHT. A DIRECT FIRED GAS MAKE-UP AIR UNIT SITS OUTSIDE THE WEST WALL. THERE ARE TWO EXHAUST UNITS ON THE ROOF WHICH OPERATE WHENEVER THE BUILDING IS OCCUPIED. THERE IS NO HEAT RECOVERY ON THE EXHAUST EQUIPMENT. LIGHTING IS FLUORESCENT. DOMESTIC HOT WATER HEATING IS PROVIDED BY ONE ELECTRIC TANK.

ENERGY : SPACE HEATING AND HEATING OF THE MAKE-UP AIR IS PROVIDED BY NATURAL GAS. THE LIGHTING AND HOT WATER USE ELECTRICITY. BOTH ELECTRIC ARC AND GAS WELDING TORCHES ARE USED.

COMMENTS : THE ATTACHED HEAT LOAD BREAKDOWN IS BASED ON AN ESTIMATED 1.5 AIR CHANGES PER HOUR, AN AVERAGE VENTILATION RATE THAT INCLUDES NATURAL INFILTRATION AND MECHANICAL EXHAUST. EVEN THOUGH THIS VALUE IS HIGH, IT IS NOT UNREASONABLE FOR A BUILDING OF THIS AGE, AND CONSTRUCTION. GIVEN THE CONSTRUCTION OF THE BUILDING AND GIVEN THAT THE WINDOWS WERE SEEN TO BE OPEN FOR VENTILATION ON A COLD WINTER DAY, THIS AIR CHANGE RATE MAY EVEN BE HIGHER. THE HIGH AIR CHANGE RATE WAS CHOSEN SINCE THE TOTAL GAS AND ELECTRIC CONSUMPTION FOR THIS AND THE ADJACENT BUILDING APPEAR TO BE RELATIVELY HIGH ON A PER UNIT FLOOR AREA AND PER UNIT VOLUME BASIS.

AT 1.5 AIR CHANGES PER HOUR, INFILTRATION/VENTILATION IS THE MOST SIGNIFICANT COMPONENT OF TH HEAT LOSS, ACCOUNTING FOR 33%. THE WALLS ARE THE NEXT MOST IMPORTANT AT 26%, FOLLOWED BY THE WINDOWS (18%), AND THE ROOF (18%).

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY



FILE NUMBER : 20601-21

BUILDING TYPE : WAREHOUSE AND TRUCK MAINTENANCE GARAGE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OWNER/OCCUPANT IN 1963. THE OCCUPANT IS AN AFFILIATE MEMBER OF A LARGE TRUCKING FIRM. ALTHOUGH ALL BILLS ARE PAID FROM THE HEAD OFFICE, EACH AFFILIATE MEMBER IS RESPONSIBLE FOR GENERATING HIS OWN BUSINESS AND PROFIT.

STRUCTURE : THE OFFICE AREA IS 238 m^2, THE LOADING AREA IS 1470 m^2, THE MAINTENANCE GARAGE IS 493 m^2. THE BUILDING HAS A STRUCTURAL STEEL FRAMEWORK WITH A LOW SLOPE PREFINISHED SHEET METAL ROOF, AND PREFINISHED SHEET METAL PANELS ON THE WALLS. THE WALLS AND ROOF OF THE HEATED AREAS ARE INSULATED. SOME OF THE ROOF PANELS OVER THE UNHEATED LOADING AREA ARE TRANSLUCENT FIBER REINFORCED PLASTIC PANELS THAT PROVIDE NATURAL LIGHT.

SYSTEMS : THERE ARE TWO SPACE HEATING SYSTEMS. THE OFFICE HAS TWO GAS FIRED FURNACES. THE LARGER FURNACE HAS SUPPLY DUCTWORK BELOW THE CONCRETE FLOOR. THE GARAGE HAS A GAS FIRED BOILER IN AN EXTERIOR MECHANICAL ROOM. THE HOT WATER IS PUMPED THROUGH FAN COIL UNITS NEAR THE CEILING. THERE ARE NO TEMPERATURE SETBACK CONTROLS ON ANY OF THE SYSTEMS.

LIGHTING IN THE OFFICE IS FLUORESCENT. IN THE GARAGE IT IS A MIXTURE OF FLUORESCENT AND H.I.D. FIXTURES. IN THE LOADING AREA NATURAL LIGHT FROM SKYLIGHTS IS SUPPLEMENTED BY INCANDESCENT FIXTURES. DOMESTIC HOT WATER IS PROVIDED BY ONE GAS FIRED TANK IN THE FURNACE ROOM.

THERE ARE TWO SMALL BLOWERS TO EXHAUST DIESEL EXHAUST FUMES IN THE GARAGE. THE TRUCK EXHAUST IS CONNECTED TO THE BLOWERS BY DUCTWORK.

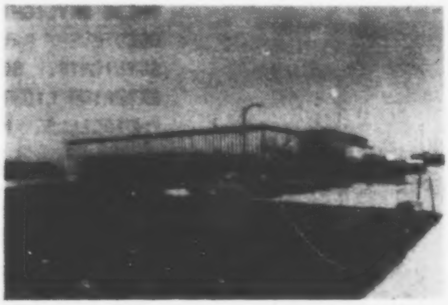
ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING. IN 1982 THE GAS CONSUMPTION WAS 2,242 GJ, $9,405, 3.1 GJ/$m^2$ YEAR, 0.61 GJ/m^2 YEAR. THESE INDICES ARE BASED ON ONLY THE HEATED AREA AND VOLUME. THE MAJOR ELECTRIC LOADS ARE LIGHTING, MOTORS, AND OFFICE EQUIPMENT. THE TOTAL ELECTRICAL CONSUMPTION IN 1982 WAS 841 GJ, $7,727, 0.38 GJ/$m^2$ (INCLUDING THE UNHEATED LOADING AREA).

COMMENTS : BOTH THE GAS AND ELECTRIC CONSUMPTION ARE HIGHER THAN EXPECTED FOR SUCH A BUILDING. THE ACTUAL FUEL CONSUMPTION IS MUCH BEYOND ANY OF THE COMPUTER PREDICTIONS, SUGGESTING THAT THERE IS EITHER A MAJOR SYSTEM PROBLEM, OR AN ERROR IN THE FUEL RECORDS. WE HAVE THEREFORE NOT USED YOUR FUEL RECORDS FOR OUR CALCULATION, HOWEVER BASED ON AN ESTIMATED NATURAL VENTILATION RATE OF 0.75 AIR CHANGES PER HOUR, THE OFFICE AREA GAS CONSUMPTION WOULD BE 418 GJ, OR $1,850 PER YEAR. THE MAJOR CONTRIBUTORS TO THE COST OF SPACE HEAT WOULD BE WALLS (51%), AIR LEAKAGE (19%), ROOF (12%), WINDOWS (9%) AND HEAT

LOSS TO THE SOIL (7%). THE GARAGE ENERGY CONSUMPTION (AT 2.0 AIR CHANGES PER HOUR) WOULD BE 1,067 GJ, $4,730 BROKEN DOWN AS FOLLOWS: AIR LEAKAGE (60%), WALLS (15%), ROOF (10%), DOORS (7%) AND HEAT LOSS TO THE SOIL (6%).

THE BLOWER ACCESS DOORS ON THE LARGE OFFICE FURNACE DO NOT FIT CORRECTLY. THIS LEADS TO AIR FROM THE LOADING AREA BEING BLOWN INTO THE OFFICE AREA. THAT AIR IS NOT ONLY COLD, BUT ALSO QUITE DUSTY.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY



FILE NUMBER : 20601-22

BUILDING TYPE : UNHEATED WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OCCUPANT/OWNER IN 1963. THE BUILDING IS A DISTRIBUTION CENTER FOR WOOD PRODUCTS AND OTHER BUILDING MATERIALS. ALL BILLS ARE APPROVED IN KITCHENER AND PAID BY A CENTRAL ACCOUNTING DEPARTMENT IN BRITISH COLUMBIA. THE WAREHOUSE PROVIDES UNHEATED DRY STORAGE FOR FINE WOODS AND PLYWOODS. THE ONLY HEATED AREA IS THE SMALL ADMINISTRATION OFFICE.

STRUCTURE : THE FLOOR AREA OF THE WAREHOUSE IS 2148 m^2. THE STRUCTURAL SYSTEM IS GLULAM COLUMNS AND BEAMS. THE WOOD STUD FRAME WALLS ARE CLAD WITH A PREFINISHED PLYWOOD PANEL. THE JOINTS BETWEEN EACH PANEL ARE CAULKED, AND COVERED WITH A WOOD BATTEN. THE WAREHOUSE AREA HAS A TYPICAL FLAT ROOF WITH A BUILT-UP MEMBRANE WHICH HAS RECENTLY BEEN ASPHALTED. AT THE SAME TIME, EXPANSION JOINTS WERE ADDED. THE ROOF DECK (7.0m ABOVE THE FLOOR) IS 63mm CEDAR PLANKS ON GLULAM BEAMS. NEITHER THE ROOF NOR THE WALLS ARE INSULATED SINCE THE WAREHOUSE IS UNHEATED. THE WAREHOUSE FLOOR IS ASPHALT PAVING.

THE OFFICE AREA IS HEATED AND AIR CONDITIONED. IT IS A ONE STOREY, 190 m^2 FLOOR AREA SPACE ON THE SOUTH SIDE OF THE WAREHOUSE. THE OFFICE AND WAREHOUSE ARE SEPARATED BY A CONCRETE BLOCK FIRE WALL, WITH THE BLOCK CORES FILLED WITH VERMICULITE INSULATION. THE EXTERIOR WOOD STUD FRAME WALLS ARE INSULATED. THEY ARE CLAD WITH WOOD.

THE OFFICE ROOF IS COMPLETELY FLAT. THE WATERPROOFING IS A FLAT BUILT UP MEMBRANE ON 25 mm RIGID INSULATION, FASTENED TO THE 63mm THICK T&G CEDAR DECK. THE GLULAM BEAMS SUPPORTING THE DECK REST ON METAL COLUMNS. THE ROOF IS NOT SLOPED, THE CENTRAL DRAIN DOES NOT SEEM TO WORK, AND THERE IS EXTENSIVE PONDING.

THERE IS AN INSULATED CRAWL SPACE FOR MECHANICAL DUCTWORK BELOW THE OFFICE AREA. THE OFFICE FLOOR IS PLYWOOD AND WOOD JOISTS.

SYSTEMS : SPACE HEATING AND COOLING IS PROVIDED BY TWO FORCED AIR NATURAL GAS FIRED FURNACES IN A FURNACE ROOM. THE LARGER FURNACE HAS THE COOLING OIL. THEY SERVICE THE OFFICE AREA ONLY. THE SUPPLY DUCTWORK RUNS THROUGH AN INSULATED CRAWLSPACE. THE SYSTEMS ARE SERVICED BY A MECHANICAL CONTRACTING FIRM WHICH SWITCHES THE ONE FURNACE FROM HEATING ONLY TO COOLING ONLY IN THE SUMMER. THERE ARE AUTOMATIC SETBACK CONTROLS. THE WAREHOUSE DOES NOT HAVE A HEATING SYSTEM.

WAREHOUSE LIGHTING IS PRIMARILY PROVIDED BY SIXTEEN CLEAR SKYLIGHTS. THESE SKYLIGHTS ARE SO EFFECTIVE THAT THE FLUORESCENT FIXTURES ARE NOT USED EVERY DAY. THE OFFICE AREA HAS FOUR, DOUBLE GLAZED, TRANSLUCENT SKYLIGHTS. SUPPLEMENTAL LIGHTING IS PROVIDED BY FLUORESCENT FIXTURES. EXTERIOR LIGHTING IS EITHER H.I.D. OR INCANDESCENT, CONTROLLED BY PHOTOCELLS. HALF OF THE OFFICE LIGHTS ARE LEFT ON AT NIGHT TO DETER VANDALISM.

THE ENTIRE BUILDING IS SPRINKLERED. THE HOT WATER TANK IS ELECTRIC. TWO OF THE FORKLIFT TRUCKS HAVE HEATED CABS.

ENERGY : NATURAL GAS ONLY PROVIDES SPACE HEATING FOR THE OFFICE. THE 1982 CONSUMPTION WAS 233 GJ/m^3, \$1126, 1.23 GJ/m^2year, 0.36GJ/m^3year. (OFFICE SPACE ONLY)

ELECTRICITY PROVIDES LIGHTING,COOLING, HOT WATER HEATING AND OPERATES MOTORS. 1982 CONSUMPTION, IN TERMS OF THE ENTIRE BUILDING WAS 292 GJ, \$3217, 0.125 GJ/m^2year.

COMMENTS : THE TOTAL ELECTRICAL COST IS THREE TIMES GREATER THAN THE SPACE HEATING FUEL COST.

THE MAJOR CONTRIBUTOR TO THE OFFICE HEATING LOAD APPEARS TO BE THE NATURAL VENTILATION RATE OF 1.5 AIR CHANGES PER HOUR. THIS SEEMS TO BE ON THE HIGH SIDE BUT IT SHOULD BE NOTED THAT THE BUILDING HAS A CRAWL SPACE AND THERE ARE TWO ENTRANCES TO THE OFFICE AREA. AIR LEAKAGE ACCOUNTS FOR 40% OF THE HEATING BILL. THE ROOF (16%), WINDOWS(15%), WALLS (15%), AND HEAT LOSS TO THE SOIL (11%) ACCOUNT FOR MOST OF THE REMAINDER.

THE WAREHOUSE ROOF DRAINS ARE EQUIPPED WITH HEATING CABLES SINCE THE AREA IS UNHEATED. THE CABLES WERE NOT OPERATING DURING THE LAST HEATING SEASON, YET NO PROBLEMS WERE REPORTED. THE OFFICE ROOF DRAIN DOES NOT HAVE A HEATING CABLE. THE ROOF DRAINS HAVE A PERIMETER RING 6 mm HIGH THAT PREVENTS COMPLETE ROOF DRAIN OFF, ESPECIALLY AT THE OFFICE ROOF. THIS ROOF WAS FULLY PONDED DURING THE SITE VISIT.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-23

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OWNER/OCCUPANT IN SEVERAL STAGES. THE MOST RECENT ADDITION WAS IN 1977. THE USES INCLUDE ADMINISTRATION OFFICES,PRODUCTION AREAS FOR THE MANUFACTURING OF JAR CAPS, AND STORAGE SPACE FOR THE SAME. THE SHIPPING/RECEIVING AREA IS SMALL. MANUFACTURING INCLUDES PLASTICS MOLDING, METAL STAMPING AND FORMING. PAINTING AND PRINTING IS DONE AT ANOTHER LOCATION. THERE IS ALSO A MACHINE SHOP THAT MAKES THE DIES FOR THE PLASTIC MOLDING EQUIPMENT. THE PLANT OPERATES 24 HOURS PER DAY 4 DAYS A WEEK.

STRUCTURE : THIS IS A ONE STOREY BUILDING WITH A TOTAL FLOOR AREA OF 2347m^2. MOST OF THIS AREA IS PRODUCTION SPACE WITH A 5.4m HIGH CEILING (SLAB TO ROOF DECK).

THE PRODUCTION/WAREHOUSE SPACE CONSISTS OF FOUR SQUARE AREAS, EACH OF ABOUT 520m^2. THE FIRST TO BE BUILT HAS LOAD BEARING CONCRETE BLOCK EXTERIOR WALLS SUPPORTING THE STEEL BEAMS AND OPEN WEB STEEL JOISTS FOR THE FLAT ROOF. THE LATER ADDITIONS HAVE SIMILAR STEEL JOISTS AND BEAMS, BUT THEY ARE SUPPORTED ON STEEL COLUMNS. THE BLOCK EXTERIOR WALLS ARE NON LOAD BEARING. ALL THE PRODUCTION AREA WALLS ARE INSULATED WITH 50mm RIGID INSULATION, AND CLAD WITH PREFINISHED SHEET METAL. THE FOUNDATION WALL AT THE PERIMETER OF THE MOST RECENT ADDITION IS INSULATED WITH 50mm OF RIGID INSULATION. THE OFFICE WALLS ARE UNINSULATED BRICK AND CONCRETE BLOCK.

THE PRODUCTION AREA ROOF IS A BUILT UP MEMBRANE ON A 25mm FIBREBOARD BASE. THE ROOF STRUCTURE IS SIMILAR TO THAT IN THE ORIGINAL PRODUCTION AREA: STEEL JOISTS ON BLOCK CONCRETE BEARING WALLS.

THE WAREHOUSE/SHIPPING AREA IS SEPARATED FROM THE REST OF THE BUILDING BY CONCRETE BLOCK WALLS AND LARGE SWINGING DOORS.

THE PRODUCTION AREA RECEIVES NATURAL LIGHT THROUGH WINDOWS HIGH IN THE EAST AND WEST WALLS.

SYSTEMS : THE OFFICE IS HEATED BY A NATURAL GAS FORCED AIR FURNACE LOCATED IN A FURNACE ROOM NEAR THE PRODUCTION AREA. THERE IS NO COOLING ASSOCIATED WITH THIS UNIT.

THE PRODUCTION AREA IS HEATED BY UNIT HEATERS AND GAS FIRED RADIANT HEATERS. BOTH ARE SUSPENDED JUST BELOW THE OPEN WEB STEEL JOISTS. NONE OF THE HEATING SYSTEMS HAVE AUTOMATIC SETBACK. THE WAREHOUSE/SHIPPING

AREA IS HEATED BY NATURAL GAS UNIT HEATERS, AGAIN MOUNTED JUST BELOW THE JOISTS. ALSO PROCESS HEAT IS DELIVERED TO THIS SPACE FROM A LARGE CHILLER UNIT.

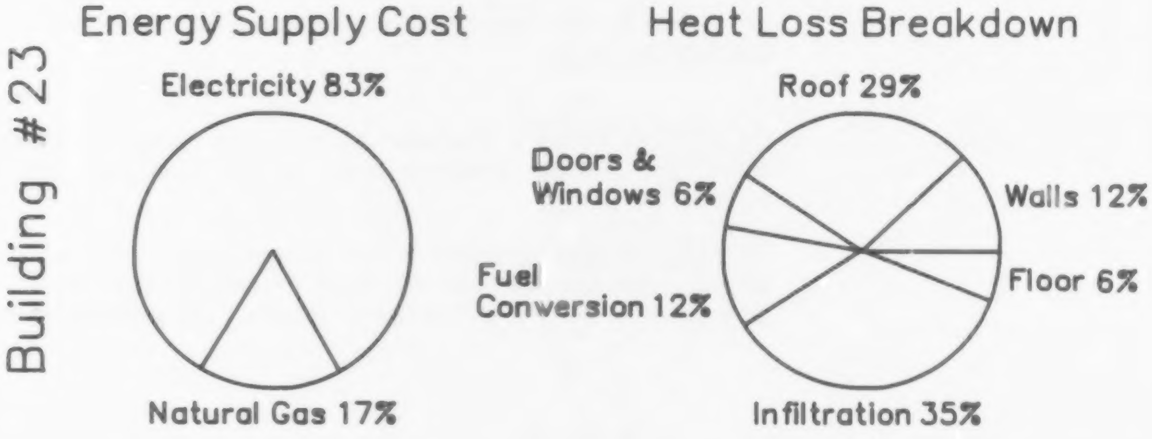
PROCESS EQUIPMENT INCLUDES TWO PLASTIC INJECTION MOLDING MACHINES. THEY ARE HEATED ELECTRICALLY. THE PROCESS REQUIRES CONTINUAL COOLING WHICH IS PROVIDED BY A LARGE COOLANT CHILLER LOCATED IN THE WAREHOUSE/SHIPPING AREA. HOT COOLANT IS PUMPED TO THIS MACHINE, COOLED, AND PUMPED BACK. THE HEAT IS EXTRACTED BY A REFRIGERATION LOOP. THE COOL AIR REQUIRED TO COOL THE REFRIGERANT AT THE "CONDENSING" COIL COMES FROM THE WAREHOUSE, PASSES THROUGH THE COIL, AND IS THEN DUCTED TO THE WAREHOUSE AND THE PRODUCTION SPACE, PROVIDING SUBSTANTIAL SPACE HEATING IN THE WINTER. HOWEVER, THIS PRACTICE DEPRESSURIZES THE WAREHOUSE AREA, CAUSING INFILTRATION DOWN THROUGH THE UNIT HEATER FLUE. THIS SITUATION IS AGGRAVATED IN THE EARLY SPRING AND LATE FALL, WHEN ALL OF THE AIR DRAWN FROM THE WAREHOUSE IS EXHAUSTED DIRECTLY OUTSIDE, DEPRESSURIZING THE ENTIRE BUILDING. WE OBSERVED THAT ALL HEATING SYSTEM FLUES WERE ACTING AS AIR INTAKES FOR THE BUILDING. THE PROCESS OVEN DESCRIBED BELOW HAS A POWER EXHAUST TO ALLEVIATE THIS PROBLEM.

TO DRY THE PASTE ON THE METAL LIDS, THE LIDS ARE SENT THROUGH A NATURAL GAS FIRED DRYER WITH TWO BURNERS. THE FLUES HAVE AN EXHAUST BLOWER WHICH ALSO CONTRIBUTES TO THE NEGATIVE PRESSURE IN THE BUILDING. THE FIRING RATE FOR THE GAS BURNERS IS NOT KNOWN.

ARTIFICIAL LIGHTING IS FLUORESCENT THROUGHOUT. NATURAL LIGHT FROM WINDOWS IS SIGNIFICANT. DOMESTIC HOT WATER HEATING IS PROVIDED BY ONE NATURAL GAS FIRED TANK IN THE OFFICE FURNACE ROOM.

ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING, DOMESTIC HOT WATER HEATING AND PROCESS DRYING. THE TOTAL 1982 CONSUMPTION WAS 1097 GJ, $4954. THE PROCESS ENERGY (AS SHOWN IN RECORDS FOR SUMMER CONSUMPTION) IS 16 GJ/MONTH. EXTRAPOLATING THIS VALUE OVER THE YEAR YIELDS AN ANNUAL PROCESS CONSUMPTION OF APPROX. 190 GJ/m^2YEAR. THE SPACE HEATING ENERGY IS CALCULATED TO BE 1,097 - 190 = 907 GJ/YEAR, $4,095, 0.39 GJ/m^2 YEAR, 0.077 GJ/m^3 YEAR.

ELECTRICAL CONSUMPTION IS PRIMARILY FOR PLASTICS EXTRUDING, AND PROCESS COOLING. LIGHTING, MOTORS, MACHINERY, AND OTHER PROCESS EQUIPMENT ARE OTHER ELECTRICAL LOADS. THE 1982 ELECTRICAL CONSUMPTION WAS 1953 GJ; $20754, 0.83 GJ/m^2YEAR.



COMMENTS : THOUGH THE ELECTRICAL ENERGY CONSUMPTION WAS ONLY TWICE THAT FOR SPACE HEATING, THE COST OF THE ELECTRICITY IS FOUR TIMES GREATER. BASED ON OUR CALCULATIONS, RECOVERING PROCESS ENERGY IN THIS BUILDING APPEARS TO HAVE CUT THE SPACE HEATING BILL IN HALF.

ALTHOUGH THIS IS NOT AN ABNORMALLY LEAKY BUILDING, THE AIR LEAKAGE RATE IS THE LARGEST SOURCE OF HEAT LOSS IN THE BUILDING, AND MOST OF THE AIR LEAKAGE (0.4 AIR CHANGES PER HOUR OF THE TOTAL 0.61 ACPH) IS ASSOCIATED WITH THE EXHAUST EQUIPMENT. AIR LEAKAGE ACCOUNTS FOR 44% OF THE HEATING BILL. THE ROOF (33%), AND THE WALLS (14%) COMPRISE THE BULK OF THE REMAINDER.

THE AIR ENTERING THROUGH THE UNIT HEATER FLUES DOES NOT IMPAIR THE OPERATION OF THE EQUIPMENT BUT IT DOES BRING THE PRODUCTS OF COMBUSTION, (i.e., CO, CO_2) INTO THE BUILDING. HOWEVER, THERE WERE NO COMPLAINTS ABOUT THE AIR QUALITY OF THE BUILDING. THE SHIPPING DOOR HAS TRAILER SEALS. THERE IS A RUBBER WEATHERSTRIPPING AT THE DOCK LEVELLER. ALSO THE DOCK LEVELLER IS INSULATED WITH 75 mm RIGID INSULATION. DESPITE THE ABOVE, WE OBSERVED SIGNIFICANT INFILTRATION AROUND THE DOCK LEVELLER.

THE MACHINE SHOP HAS A GAS FIRED RADIANT HEATING SYSTEM. THE LATHE OPERATOR AT THE SOUTH END OF THE BUILDING INDICATES THAT THIS AREA IS OFTEN COLD, POSSIBLY BECAUSE EXPERIENCING DISCOMFORT SINCE HE FACES THE RADIANT SYSTEM, BUT HAS HIS BACK TOWARD A COOL EXTERIOR WALL.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-24

BUILDING TYPE : WAREHOUSE AND OFFICES

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : MARKHAM, ONTARIO

OCCUPANCY : THE BUILDING WAS COMPLETED IN 1983. THE OWNER/OCCUPANTS USE IT AS HEAD OFFICE AND WAREHOUSE SPACE FOR THE STORAGE, PACKING AND DISTRIBUTION OF BOOKS. PRINTING IS DONE ELSEWHERE. THERE IS ONLY ONE SHIFT PER DAY. ONE STAFF MEMBER IS RESPONSIBLE FOR MONITORING ENERGY CONSUMPTION AND RECOMMENDING ACTION.

STRUCTURE : THIS BUILDING IS DESIGNED AND DETAILED TO REDUCE ENERGY CONSUMPTION. THE ROOF AND WALLS, EVEN WALLS BELOW GRADE, ARE INSULATED. EFFICIENT HEATING AND LIGHTING SYSTEMS ARE ALSO USED.

THE STRUCTURE IS STEEL BEAMS AND COLUMNS. THE PRECAST CONCRETE EXTERIOR WALLS ARE NON-LOADBEARING. THE ROOF IS FLAT WITH A BUILT UP MEMBRANE ON RIGID INSULATION. IT IS SUPPORTED ON A STEEL DECK ON OPEN WEB STEEL JOISTS. THE WINDOWS ARE SEALED DOUBLE GLAZING IN ALUMINUM FRAMES. THE FOUR SHIPPING DOORS ARE INSULATED. THEY ARE WELL WEATHERSTRIPPED. EACH HAS TRUCK SEALS.

SYSTEMS : THE OFFICES ARE HEATED AND COOLED BY ROOFTOP FORCED AIR EQUIPMENT. THERE ARE MOTORIZED DAMPERS THAT WILL BRING IN OUTSIDE AIR FOR FIRST STAGE COOLING. THESE DAMPERS ARE WEATHERSTRIPPED. THE COMPUTER ROOM HAS ITS OWN COOLING SYSTEM. A SPLIT SYSTEM WITH THE CONDENSING COIL OUTSIDE AND THE EVAPORATION COIL INSIDE THE COMPUTER ROOM. THE SMALL LOTS "PICKING AREA" BELOW THE OFFICES HAS A FORCED AIR SYSTEM WITH A HEATING UNIT MOUNTED ON THE ROOF. THE WAREHOUSE IS HEATED BY A GAS FIRED RADIANT TUBE SYSTEM WITH A CENTRAL EXHAUST.

LIGHTING IS FLUORESCENT IN THE OFFICES AND THE "PICKING AREA". HIGH PRESSURE SODIUM LIGHTS ARE USED IN THE WAREHOUSE AND PACKING AREAS. THERE ARE NO AUTOMATIC SETBACK OR PARTIAL SHUT DOWN SYSTEMS ON THE HEATING OR THE LIGHTING SYSTEMS.

ENERGY : THERE ARE NO FUEL CONSUMPTION RECORDS FOR THIS BUILDING. A THERMAL ANALYSIS WILL BE COMPLETED AFTER THE BUILDING HAS BEEN OCCUPIED FOR A COMPLETE HEATING SEASON AND ENERGY CONSUMPTION INDICES WILL BE CALCULATED AT THAT TIME.

COMMENTS : THE BUILDING IS QUITE NEW. AS IT WAS DESIGNED TO REDUCE ENERGY CONSUMPTION, COMMENTS ARE MOSTLY FAVOURABLE. SPACE HEAT ENERGY CONSERVATION MEASURES INCLUDE 100 mm RIGID ROOF INSULATION, 50 mm RIGID INSULATION IN THE PRECAST WALL PANELS, 90 mm BATT INSULATION AT THE OFFICE WALLS, 180 mm BATT INSULATION AT THE OVERHANGING OFFICE FLOORS, 50 mm RIGID INSULATION AT THE WALLS BELOW GRADE, AND 50 mm RIGID INSULATION ON THE FOUNDATION WALLS TO 600 mm BELOW GRADE.

THE AIR SEAL IN THE WAREHOUSE SHOULD BE EXCELLENT SINCE THE ROOF IS AIR TIGHT (NO FLUE PENETRATIONS) AND THE PRECAST PANELS ARE WELL CAULKED. THE SHIPPING AREA IS SEPARATED FROM THE REST OF THE BUILDING BY CONCRETE BLOCK WALLS WITH PLASTIC STRIP CURTAINS OVER THE OPENINGS. DEPENDING UPON THE QUALITY OF THE CONSTRUCTION, THE OFFICE FLOOR OVERHANGS MAY BE A SOURCE OF AIR LEAKAGE. THIS CAN BE CHECKED WITH INFRA-RED SCANNING EQUIPMENT DURING THE HEATING SEASON. THE OFFICE AREA IS WELL LIT BY NATURAL LIGHT. THE LARGE SOUTH OVERHANGS REDUCES GLARE.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-25

BUILDING TYPE : INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT IN FOUR STAGES (1954, 1957, 1966 AND 1976) AND NOW INCLUDES OFFICE SPACE (32%), PRODUCTION (40%) AND WAREHOUSE (20%) AREAS. THE BUILDING IS OWNED BY THE OCCUPANTS. THE FACILITY HAS BEEN EXPANDED, HOWEVER IT HAS ALWAYS BEEN USED AS THE HEAD OFFICE, PRODUCTION FACILITY AND WAREHOUSE FOR A LARGE PHARMACEUTICAL FIRM.

STRUCTURE : DESPITE THE MANY ADDITIONS, THE STRUCTURE IS CONSISTENTLY STEEL TRUSSES OR STEEL JOISTS ON STEEL BEAMS AND COLUMNS. THE INTERIOR AND EXTERIOR WALLS DO NOT SUPPORT THE ROOF. THE ROOF IS INSULATED ALTHOUGH THE THICKNESS VARIES. ONLY THE WALLS IN THE 1976 ADDITION ARE INSULATED. THEY ARE STEEL CLAD WITH A STEEL LINER. THE REMAINING WALLS ARE TYPICALLY THREE WYTHES OF BRICK, OR BRICK AND BLOCK. THE GROUND FLOOR AREA IS 13,514 m^2. THE WALL HEIGHT VARIES, BEING 4.0 m AT THE OFFICES, 5 m IN THE PRODUCTION AREAS, AND 6.6 m IN THE WAREHOUSE.

THE SHIPPING AREAS ARE ENCLOSED BY BLOCK WALLS, TWO SETS OF OVERHEAD DOORS KEEP THEM THERMALLY ISOLATED FROM THE REST OF THE BUILDING. DUE TO THE NATURE OF THEIR PRODUCT, THIS AREA IS CAREFULLY CONTROLLED BY SECURITY PERSONNEL.

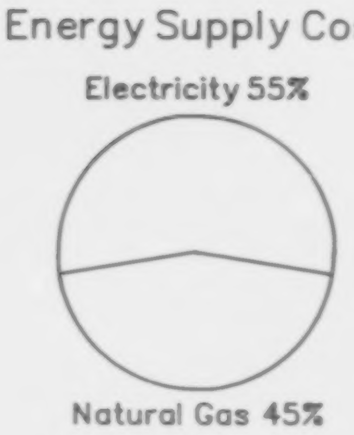
SYSTEMS : MOST SPACE HEATING IS PROVIDED BY A CENTRAL BOILER SYSTEM. THE 1976 OFFICE ADDITION IS HEATED AND COOLED BY ROOF TOP UNITS, AND A FEW OFFICES HAVE ELECTRIC BASEBOARD HEATERS. WITHIN THE BUILDING THERE ARE SEVERAL AIR CONDITIONER UNITS THAT REMOVE HEAT FROM ROOMS WITH CAREFUL CLIMATE CONTROL, AND RELEASE IT TO THE WAREHOUSE. THERE ARE NUMEROUS EXHAUST SYSTEMS, AND DESPITE THE INCLUSION OF MAKE-UP AIR UNITS, THE BUILDING IS DEPRESSURIZED CONTINUALLY. THE EXHAUST UNITS ARE NOT CONTROLLED BY THE PROGRAMMABLE TIMER THAT TURNS THE OFFICE HEAT DOWN AT NIGHT. THE PROCESS EQUIPMENT IS EXTENSIVE AND APPEARS TO CONSUME MOST OF THE ENERGY. NO INFORMATION WAS COLLECTED ABOUT THE PROCESS EQUIPMENT.

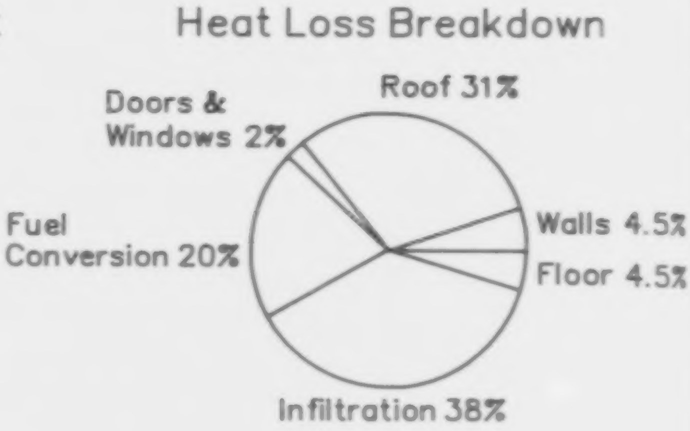
THE LIGHTING IS TYPICALLY FLUORESCENT THROUGHOUT. IT IS SWITCHED OFF MANUALLY WHEN THE JANITORIAL STAFF IS FINISHED AT NIGHT.

ENERGY : NATURAL GAS PROVIDES PROCESS HEAT, SPACE HEAT AND HOT WATER. MANUFACTURING PROCESSES APPEARED TO CONSUME 66% TO 78% OF THE NATURAL GAS USED IN THE BUILDING IN 1982. THE 1982 SPACE HEAT ENERGY IS ESTIMATED TO BE BETWEEN 14,347 - 10,315 GJ, 1.06 - 0.76 GJ/m^2 YEAR, 0.17 - 0.12 GJ/m^3 YEAR, $63,000 - $43,000. THE NATURAL GAS CONSUMPTION FOR THE LAST FIVE YEARS AVERAGES 46,340 GJ/YEAR.

THE TOTAL 1982 ELECTRICAL CONSUMPTION WAS 18,332 GJ, $173,068. IT IS ESTIMATED THAT ONLY 44% OF THIS ENERGY REDUCES THE SPACE HEATING LOAD, THE REMAINDER IS MECHANICALLY EXHAUSTED FROM THE BUILDING.

Building #25





COMMENTS : THE ENERGY CONSUMPTION IN THIS BUILDING IS PRIMARILY DEPENDANT UPON MANUFACTURING PROCESSES AND SECONDLY UPON THE BUILDING ENVELOPE AND THE WEATHER.

THE ROOF MEMBRANE OVER THE 1966 ADDITION HAS DETERIORATED AND WATER BELOW THE FELT AND ASPHALT WAS FOUND IN SEVERAL LOCATIONS. SUBSTANTIAL REPAIRS ARE PLANNED FOR THIS AREA OF THE ROOF. THE COMPANY IS CONSIDERING INCLUDING MORE INSULATION, THE AMOUNT WILL BE BASED ON PROJECTED FUEL SAVINGS. OTHER ROOF AREAS APPEARED TO BE IN GOOD CONDITION, AND ONLY SOME FLASHING REQUIRES IMPROVEMENT.

THE COMBINED MECHANICAL AND NATURAL AIR CHANGE RATE IS ESTIMATED TO BE BETWEEN 0.4 and 0.65 AIR CHANGES PER HOUR. THERE ARE MANY SEPARATE EXHAUST UNITS INVOLVED IN THE MANUFACTURING PROCESSES. EXHAUST AIR FLOW WOULD SEEM TO EXCEED MAKE-UP AIRFLOW SINCE THE BUILDING WAS DEPRESSURIZED WHEN WE OBSERVED IT. THERMOGRAPHY INDICATED INFILTRATION EVEN ON THE LEEWARD WALL. THE EXHAUST UNITS OPERATE CONTINUOUSLY, POSSIBLY TO MAINTAIN THE AIR QUALITY IN THE STERILE ROOMS. BECAUSE THE INFILTRATION IS LARGELY A RESULT OF MECHANICAL EXHAUST, AIR TIGHTENING MEASURES WILL HAVE LESS EFFECT THAN USUAL UNLESS THE EXHAUST UNITS ARE CONTROLLED DIFFERENTLY. HOWEVER, THE FROZEN SPRINKLER PIPE ABOVE THE PLASTER CEILING AT THE NORTH WALL APPEARS TO BE CAUSED BY WIND INDUCED INFILTRATION, ALTHOUGH THE EXACT LEAKAGE LOCATION COULD NOT BE DETERMINED. THAT FREEZING PROBLEM HAS BEEN ADDRESSED BY INSTALLING A HEATER ON THE HIDDEN PIPE.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-26

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : GUELPH, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT BY THE PREVIOUS OWNER, A DISTRIBUTOR AND CUTTER OF FINE STONE FACINGS FOR BUILDINGS. THE CONSTRUCTION DATE IS NOT KNOWN, HOWEVER THE BUILDING APPEARS TO BE LESS THAN 10 YEARS OLD. THE CURRENT OWNER/OCCUPANT BOUGHT THE BUILDING IN 1981, AND HAS MADE SEVERAL CHANGES. THE COMPANY BUILDS CUSTOM WOOD FURNITURE. THERE WILL USUALLY BE FIVE TO SEVEN PEOPLE IN THE BUILDING, WORKING EIGHT HOURS PER DAY.

STRUCTURE : THE GROUND FLOOR AREA IS 632 m^2. OF THIS AREA 75 m^2 IS USED AS OFFICE AND SHOWROOM AND ABOVE THIS A 75 m^2 MEZZANINE IS USED AS A SHOWROOM. IN THE PRODUCTION AREA THE CLEAR HEIGHT IS 5.7 m FROM THE STEEL DECK TO THE SLAB. THE ROOF IS FLAT WITH A BUILT-UP MEMBRANE ON RIGID INSULATION. THE STEEL DECK IS SUPPORTED ON OPEN WEB STEEL JOISTS. THE EXTERIOR CONCRETE BLOCK WALLS ARE LOAD BEARING. ALL WALLS BUT THE FRONT WALLS HAVE BEEN RETROFITTED WITH STEEL CLADDING AND RIGID INSULATION. THERE ARE TWO 3.7 m x 3.7 m SHIPPING DOORS ON THE WEST SIDE OF THE BUILDING.

SYSTEMS : THE OFFICE AND MEZZANINE AREA ARE HEATED BY ONE DOWN FLOW NATURAL GAS FURNACE LOCATED ON THE MEZZANINE FLOOR. THERE IS NO AIR CONDITIONING IN THE OFFICES. THERE ARE NO AUTOMATIC SET BACK CONTROLS ON ANY HEATING SYSTEMS.

A GAS FIRED RADIANT SYSTEM WITH A CENTRAL EXHAUST HEATS THE PRODUCTION SPACE. THIS SYSTEM WAS CHOSEN PRIMARILY BECAUSE SAFETY CODES WOULD NOT PERMIT AN OPEN FLAME IN A BUILDING WITH SUCH A HIGH CONTENT OF VERY FINE SAWDUST PARTICLES IN THE AIR, AS AN EXPLOSION COULD OCCUR. THIS HEATING SYSTEM IS SPARK IGNITED AND ALL COMBUSTION AIR IS FILTERED BEFORE IT ENTERS THE COMBUSTION CHAMBER/TUBE. THE SAWDUST LEVEL IN THE AIR IS CONTROLLED BY A CENTRAL EXHAUST SYSTEM IN THE DUCTWORK LEADING TO ALL DUST SOURCES. THIS SYSTEM IS MANUALLY OPERATED AS REQUIRED. THERE ARE ALSO TWO EXHAUST UNITS FOR A PAINT AND A GLUE SPRAY BOOTH, AGAIN USED ONLY AS REQUIRED.

PROCESS EQUIPMENT INCLUDES A 30-amp ELECTRIC AIR COMPRESSOR, TWO TABLE SAWS, ONE PLANER, AND OTHER WOODWORKING EQUIPMENT. THE LIGHTING IS FLUORESCENT THROUGHOUT. THE FIXTURES ARE COVERED WITH SAW DUST IN THE SHOP AREA. THE EXTERIOR SIGN IS THE ONLY ITEM OF EQUIPMENT CONTROLLED BY AN AUTOMATIC TIMER.

ENERGY : NATURAL GAS IS ONLY USED FOR SPACE HEATING. ELECTRICITY PROVIDES ALL LIGHTING AND PROCESS REQUIREMENTS. NO ELECTRICITY BILLS WERE AVAILABLE AND AN ANALYSIS OF ELECTRICITY USE IS NOT POSSIBLE. AN ESTIMATE OF

ELECTRICAL HEAT GAINS (BASED ON USE IN SIMILAR BUILDINGS) IS USED IN THE ANALYSIS OF SPACE HEATING. THE SPACE HEATING CONSUMPTION OVER THE 1982/83 HEATING SEASON WAS 447 GJ, $2,817, 0.707 GJ/m^2 YEAR, 0.124 GJ/m^3 YEAR.

COMMENTS : THE WALLS (42%) AND THE ROOF (25%) ARE THE MOST SIGNIFICANT COMPONENTS OF THE ANNUAL HEAT LOSS, EVEN THOUGH BOTH ARE INSULATED. THE AIR LEAKAGE AND MECHANICAL EXHAUST RATE OF 0.25 AIR CHANGES PER HOUR IS ALSO IMPORTANT (17%). SINCE THE SHIPPING DOORS ARE RARELY USED, THE BUILDING CRACKS WILL BE THE MAJOR SOURCE OF NATURAL INFILTRATION. WHEN THE RIGID INSULATION WAS ADDED TO THE OUTSIDE SURFACE OF THE BLOCK WALLS, A CONTINUOUS AIR SEAL/VAPOUR BARRIER WAS NOT INCLUDED BETWEEN THE INSULATION AND THE CONCRETE BLOCK WALL.

THE CO-RAY-VAC RADIANT HEATING SYSTEM IN THE PRODUCTION AREA REPLACED ANOTHER GAS FIRED RADIANT HEATER WHICH HAD AN OPEN PILOT FLAME, AND WAS LESS EFFICIENT. THE OCCUPANTS ARE QUITE SATISFIED WITH THE NEW SYSTEM. HOWEVER, ONE COMBUSTION TUBE IS IMMEDIATELY ADJACENT TO THE MEZZANINE STAIR LANDING, I.E., WITHIN REACH. THIS MAY BE A SAFETY HAZARD IF THE SHOWROOM BECOMES A MORE PUBLIC SPACE THAN IT IS NOW. THE RADIANT TUBE OPERATES AT ABOUT 450°C.

THE OFFICE FURNACE RESTS ON THE MEZZANINE FLOOR. THE BLOWER MOTOR VIBRATES THE FLOOR WHEN THE FURNACE OPERATES.

THE NATURAL GAS BILL FOR THE METER READING DATE 02-07-83 WAS $941 FOR 2541 m^3 OF GAS. THIS QUANTITY OF GAS SHOULD COST $508, A DIFFERENCE OF $433 WHICH SHOULD BE DISCUSSED WITH THE UTILITY.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-27

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE OWNER/OCCUPANTS BUILT THIS ORIGINAL BUILDING IN 1956. THERE WERE MAJOR ADDITIONS IN 1959, 1963 AND 1969. THE BUILDING IS USED PRIMARILY AS A LARGE MACHINE SHOP, PRODUCING CUSTOM PARTS. THERE ARE ALSO SHIPPING,STORAGE AND OFFICE AREAS. NORMAL OCCUPANCY IS 20 TO 30 PEOPLE FOR EIGHT HOURS PER DAY, HOWEVER, IN 1983 A DOUBLE SHIFT WAS USED.

STRUCTURE : THE GROUND FLOOR AREA IS 1,636 m^2, OF WHICH 11% OR 187 m^2 IS OFFICE AREA. THERE IS A FULL BASEMENT BELOW THE OFFICES THAT IS USED FOR CHANGE ROOMS AND MECHANICAL ROOMS. SINCE THE BUILDING WAS BUILT IN FOUR STAGES, WALL CONSTRUCTION IS NOT CONSISTENT. THE ONLY LOAD BEARING WALLS ARE IN THE OFFICE AREA WHERE THE ROOF IS SUPPORTED ON CONCRETE BLOCK FACED WITH BRICK. THE PRODUCTION AREA, BUILT AT THE SAME TIME (1956), HAS NON-LOAD BEARING CLAY TILE WALLS. THE ROOF IS SUPPORTED ON STEEL BEAMS AND COLUMNS. THE STEEL DECK IS EITHER 3.6 m OR 4.9 m ABOVE THE FLOOR SLAB. THE PRODUCTION AREA ADDITIONS HAVE CLAY TILE WALLS, HOWEVER, THE 1969 ADDITION HAS A TEMPORARY WALL (SOUTH MOST WALL OF BUILDING) IN ANTICIPATION OF FUTURE EXPANSION. THIS IS WOOD FRAME CLAD WITH RIGID INSULATION BETWEEN 4 mm ASBESTOS BOARDS.

THE ROOF IS A BUILT UP MEMBRANE ON RIGID INSULATION , ON EITHER A WOOD OR A STEEL DECK AS IN THE 1969 ADDITION.

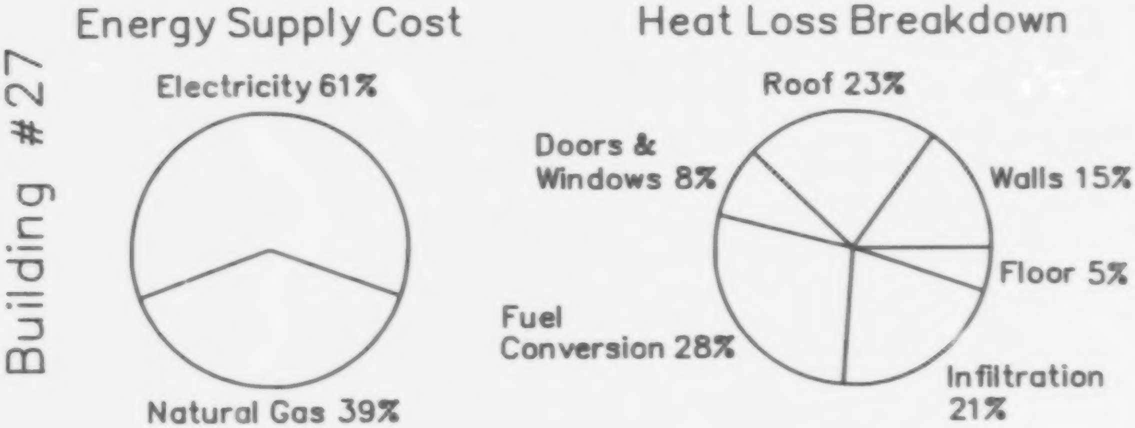
THERE ARE LARGE WINDOW AREAS FACING EAST AND WEST IN THE MACHINE SHOP PROVIDING NATURAL LIGHT. THE WINDOWS ARE OPENABLE, AND ARE THE PRIMARY SOURCE OF FRESH AIR.

SYSTEMS : MOST OF THE BUILDING IS HEATED BY A NO. 2 FUEL OIL FIRED BOILER BELOW THE OFFICES. THERE ARE FOUR HEAT SUPPLY LOOPS WITH ZONE CONTROL VALVES THAT OPEN WHEN THE APPROPRIATE THERMOSTAT CALLS FOR HEAT. THE CIRCULATION PUMP OPERATES CONTINUOUSLY. THE HEAT IS DELIVERED TO THE SPACE BY HOT WATER RADIATORS.

THE SHIPPING AREA AND THE MOST RECENT ADDITION ARE HEATED BY NATURAL GAS FIRED UNIT HEATERS SUSPENDED FROM THE OPEN WEB STEEL JOISTS. THE ONLY COOLING SYSTEMS ARE THREE WINDOW MOUNTED AIR CONDITIONERS IN THE OFFICE AREA. THERE ARE NO SETBACK CONTROLS ON THE HEATING OR COOLING SYSTEMS. THE HEAT TREATING ROOM HAS ITS OWN EXHAUST SYSTEM. THE AIR COMPRESSOR (ELECTRIC) IS AIR COOLED; IN THE WINTER THIS HOT AIR IS DUCTED INTO THE MACHINE SHOP.IN THE 1969 ADDITION THERE IS AN ELECTRONIC AIR CLEANER, WITH DUCTWORK CONNECTIONS TO VARIOUS PIECES OF METAL CUTTING EQUIPMENT. IT IS INTENDED TO KEEP PARTICLES OF COOLANT OUT OF THE AIR. THE LIGHTING IS FLUORESCENT THROUGHOUT. THE REFLECTORS IN THE MACHINE SHOP ARE COVERED WITH AN OIL FILM.

ENERGY : NO. 2 FUEL OIL AND NATURAL GAS PROVIDE ALL SPACE HEATING . THE 1982 HEATING ENERGY CONSUMPTION WAS 1,701 GJ, \$9,596 FOR OIL, \$2,155 FOR NATURAL GAS, \$11,751 TOTAL, 1.04 GJ/m^2 YEAR, 0.25 GJ/m^3 YEAR.

THE MAJOR ELECTRICAL LOAD IS LIGHTING. OTHER USES INCLUDE THE HEAT TREATMENT OF METALS, AN AIR COMPRESSOR, PRODUCTION MACHINERY, COOLING, AND MISCELLANEOUS MOTORS. THE 1982 ELECTRIC CONSUMPTION WAS 1,192 GJ, \$17,668 ENERGY CHARGES, \$2,425 DEMAND CHARGES, \$20,093 TOTAL, 0.73 GJ/m^2 YEAR.



COMMENTS : THE ROOF (32%) IS THE MAJOR HEAT LOSS ROUTE. IT HAS A LARGE SURFACE AREA AND LITTLE INSULATION. THE AIR LEAKAGE RATE OF 0.62 AIR CHANGES PER HOUR IS ALSO QUITE SIGNIFICANT (27%). HOWEVER, ANY REDUCTION IN THAT NATURAL VENTILATION MIGHT LEAD TO AN AIR QUALITY PROBLEM IN THIS BUILDING.

THE ANNUAL COST OF ELECTRICITY IS MUCH GREATER THAN THAT FOR SPACE HEATING, \$20,093 vs \$11,751. PROCESS ENERGY APPEARS TO BE MORE SIGNIFICANT THAN LIGHTING, BASED ON A TYPICAL LIGHTING DOMINATED CONSUMPTION RATE OF 0.2 GJ/m^2 YEAR. IT IS BEYOND THE SCOPE OF THIS REPORT TO DISCUSS PROCESS ENERGY CONSUMPTION IN DETAIL.

ENERGY CONSERVATION MEASURES ALREADY IMPLEMENTED INCLUDE SIDE WEATHER STRIPPING ON THE SHIPPING DOORS, A PLASTIC CURTAIN THAT CAN ENCLOSE A LARGE AREA AROUND A RECEIVING DOOR TO REDUCE INFILTRATION AND A DAMPER IN THE EXHAUST DUCT FROM THE COMPRESSOR COOLING BLOWER THAT BLOWS THE HEATED AIR INTO THE BUILDING IN THE WINTER.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-28

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : GUELPH, ONTARIO

OCCUPANCY : THE ORIGINAL BUILDING WAS BUILT IN 1970 BY THE PREVIOUS OWNER. THE CURRENT OCCUPANT BOUGHT THE BUILDING IN 1975 AND BUILT AN 1,860 m² PRODUCTION AREA ADDITION. THIS COMPANY RECENTLY SOLD CONTROLLING INTEREST TO A GROUP OF STOCKHOLDERS. THE COMPANY MANUFACTURES EQUIPMENT AND FURNITURE FOR DRAFTING OFFICES. THE BUILDING IS USUALLY OCCUPIED FOR ONE SHIFT OF EIGHT HOURS. THE LEVEL OF PRODUCTION THROUGHOUT 1982 WAS LOW.

STRUCTURE : THE BUILDING IS ONE STOREY. THE TOTAL GROUND FLOOR AREA IS 1,569 m². THE OFFICE AREA COMPRISES 4% OR 59 m². THE CLEAR HEIGHT IS 3.36 m IN THE OFFICE AND 4.75 IN THE PRODUCTION AREA.

THE ROOF STRUCTURE IS A STEEL DECK SUPPORTED ON OPEN WEB STEEL JOISTS ON STEEL BEAMS AND COLUMNS. THE FLAT ROOF IS A BUILT UP MEMBRANE ON RIGID INSULATION. THE EXTERIOR CONCRETE BLOCK WALL IS LOADBEARING. THE PRODUCTION AREA WALLS ARE INSULATED AND CLAD WITH PREFINISHED SHEET METAL. THE UNINSULATED BLOCK WALLS IN THE OFFICE AREA ARE CLAD WITH BRICK.

SYSTEMS : THE PRODUCTION AREA IS HEATED BY DIRECT FIRED NATURAL GAS RADIANT HEATERS SUSPENDED BELOW THE ROOF. NEAR THE SHIPPING DOORS THERE ARE NATURAL GAS UNIT HEATERS WHICH ARE FITTED WITH BLOWER POWERED FLUES SINCE THE BUILDING OFTEN OPERATES UNDER NEGATIVE PRESSURE. THE OFFICE IS HEATED BY ELECTRIC BASEBOARD CONVECTORS. THERE ARE NO AUTOMATIC SETBACK CONTROLS ON THE HEATING SYSTEMS. THERE IS ONE AIR CONDITIONER INSTALLED IN AN OFFICE WALL.

LIGHTING IS FLUORESCENT THROUGHOUT. THERE ARE NO AUTOMATIC CONTROLS ON THE LIGHTING SYSTEM.

THE MOST SIGNIFICANT PROCESS EQUIPMENT IS A LARGE GAS FIRED PAINT DRYING UNIT. IT HAS TWO BURNERS AND A LARGE EXHAUST BLOWER. WHEN THE BLOWER COMES ON, THE BUILDING IS UNDER NEGATIVE PRESSURE SINCE THERE IS NO MAKE UP AIR SYSTEM. OTHER EXHAUST EQUIPMENT INCLUDES THAT FOR THE PAINT BOOTH, A WELDING AREA, AND SAWDUST REMOVAL. ALL ARE USED ON AN "AS REQUIRED" BASIS. THERE IS ALSO A NATURAL GAS FIRED CARBON TETRA-CHLORIDE ETCHING TANK THAT IS HEATED TO 60°C, HOWEVER, IT IS RARELY USED.

ENERGY : NATURAL GAS PROVIDES SPACE HEAT FOR THE PRODUCTION AREA, AND HEAT IN THE PAINT DRYING OVEN AND THE ETCHING TANK. THE TOTAL 1982 CONSUMPTION IS 1,245 GJ. AS THE 1982 PRODUCTION LEVEL WAS LOW, LITTLE USE WAS MADE OF THE PAINT DRYER AND THE ETCHING TANK. THE AVERAGE SUMMER CONSUMPTION IS 26 GJ/MONTH.

THE FOLLOWING ESTIMATES OF PROCESS NATURAL GAS CONSUMPTION ARE USED IN THE ANALYSIS:

26 GJ/MONTH x 5 MONTHS x 100% = 130 GJ
26 GJ/MONTH x 4 MONTHS x 50% = 52 GJ
26 GJ/MONTH x 3 MONTHS x 25% = 21 GJ
= 203 GJ/YEAR OF NATURAL GAS CONSUMPTION
THAT DOES NOT CONTRIBUTE TO SPACE HEATING

THE 1982 SPACE HEATING GAS CONSUMPTION IS ESTIMATED TO BE (1,245 GJ - 203 GJ) = 1,042 GJ, $4,522, 0.66 GJ/m^2, 0.15 GJ/m^3 YEAR.

ELECTRICITY PROVIDES ALL LIGHTING, OFFICE HEATING, AND SOME PROCESS ENERGY. 1982 CONSUMPTION WAS 486 GJ, $5,147, 0.31 GJ/m^2 YEAR.

COMMENTS : THE ANNUAL ELECTRICITY COST EXCEEDS THE THE COST OF THE NATURAL GAS USED TO PROVIDE SPACE HEATING.

AT 33% AND 30% RESPECTIVELY, THE ROOF, AND THE NATURAL VENTILATION RATE OF 0.5 AIR CHANGES PER HOUR, ARE THE MOST SIGNIFICANT COMPONENTS OF THE ANNUAL HEAT LOSS. THE INSULATED WALLS (19%) ACCOUNT FOR MUCH OF THE REMAINDER. SINCE THE PAINT DRYING UNIT WAS NOT USED EXTENSIVELY IN 1982, THE HEAT LOSS ASSOCIATED WITH THE EXHAUST SYSTEM WAS NOT SIGNIFICANT.

WHEN THE HEATING SYSTEM WAS CHANGED FROM GAS UNIT HEATERS TO THE CURRENT GAS FIRED RADIANT SYSTEM, THREE OF THE UNIT HEATER FLUES WERE NOT SEALED OFF, LEAVING 150 mm DIAMETER OPENINGS THROUGH WHICH AIR WILL ESCAPE. ANOTHER UNIT HEATER FLUE WAS CAPPED WITH A STEEL BUCKET AND A CONCRETE BLOCK. THE BUCKET HAS NOW RUSTED TO SUCH AN EXTENT THAT THIS IS ALSO A SOURCE OF AIR LEAKAGE.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-29

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OCCUPANT IN 1973. THE COMPANY REPAIRS BOILERS. TYPICALLY THERE WILL BE THREE TO FIVE PEOPLE IN THE BUILDING FOR EIGHT HOURS PER DAY.

STRUCTURE : THE BUILDING IS A SMALL, SINGLE STOREY PREENGINEERED STEEL BUILDING. THE GROUND FLOOR AREA IS 373 m², OF WHICH 93 m² IS OFFICE AREA. THERE IS A 93 m² STORAGE MEZZANINE ABOVE THE OFFICE AREA. THE SIDE WALLS ARE 4.2 m HIGH, AND THE CENTER RIDGE IS 0.6 m ABOVE THAT.

THE ROOF IS PREFINISHED SHEET METAL (1 IN 12 SLOPE) SUPPORTED ON STEEL PURLINS ON STEEL FRAMES. THERE ARE NO INTERNAL COLUMNS AS THE BUILDING IS ONLY 15.25 m WIDE. THE ROOF AND THE UPPER 1.8 m OF ALL WALLS ARE INSULATED WITH FIBERGLASS BATTS. AND COVERED WITH A VINYL VAPOUR BARRIER. THE LOWER WALL AREAS ARE 2.4 m HIGH CONCRETE BLOCK WITH UREA FORMALDEHYDE FOAM INSULATION IN THE CORES. THE FRONT WALL IS DECORATIVE CONCRETE BLOCK WITH RIGID INSULATION AND DRYWALL ON THE INTERIOR. THE WEST FACING SHIPPING DOOR IS TRANSLUCENT PLASTIC. IT PROVIDES CONSIDERABLE NATURAL LIGHT.

SYSTEMS : MOST SPACE HEATING IS PROVIDED BY A GAS FIRED BOILER THAT WAS MODIFIED TO SUIT THE BUILDING. HEAT IS DELIVERED TO THE PRODUCTION AREA BY FOUR FAN COIL UNITS SUSPENDED FROM THE STEEL FRAMES, AND TO THE OFFICE BY PIPE RADIATORS. THE WATER IS CIRCULATED BY A PUMP.

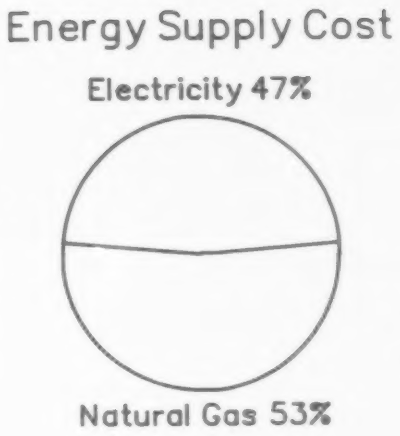
ELECTRIC BASEBOARD HEATERS PROVIDE SUPPLEMENTAL HEATING IN THE OFFICE AREA. THERE ARE NO AUTOMATIC SETBACK CONTROLS FOR THE HEATING SYSTEMS. THE PRODUCTION AREA IS KEPT COOLER THAN THE OFFICE AREA. THERE IS A 2,000 CFM EXHAUST FAN IN THE SOUTH EAST WALL THAT IS ONLY TURNED ON WHEN THE SPRAY PAINT EQUIPMENT IS BEING USED.

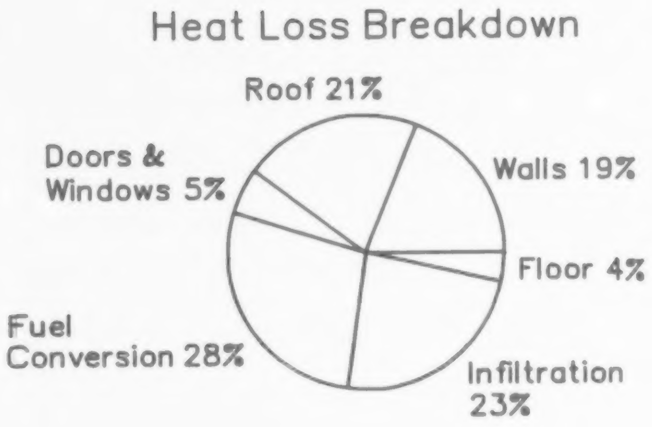
ENERGY : NATURAL GAS IS USED PRIMARILY FOR SPACE HEATING. SINCE THE COMPANY REBUILDS BOILERS, SOME NATURAL GAS IS USED WHEN THE UNITS ARE TESTED. EACH TEST LASTS FOR ONE HOUR, AND THE GAS CONSUMPTION IS SMALL. IN 1982 THE TOTAL NATURAL GAS CONSUMPTION WAS 409 GJ, $1,968, 1.1 GJ/m² YEAR, 0.25 GJ/m³ YEAR.

ALTHOUGH THERE IS SPACE HEATING EQUIPMENT THAT IS WOOD FIRED, NO WOOD CONSUMPTION WAS REPORTED FOR THE 1982 HEATING SEASON.

THE MAJOR ELECTRICAL LOAD IS LIGHTING. OTHER USES INCLUDE OFFICE SPACE HEAT AND SOME TESTING OF BOILERS. IN 1982 THE TOTAL ELECTRICAL CONSUMPTION WAS 152 GJ, $1,766, 0.41 GJ/m² YEAR.

Building #29





COMMENTS : THE ROOF (30%) , AIR LEAKAGE (30%) AND THE WALLS (27%) ACCOUNT FOR THE BULK OF THE HEAT LOSS. THE NATURAL VENTILATION RATE IS ESTIMATED TO BE 0.62 AIR CHANGES PER HOUR.

THE OCCUPANTS ARE SATISFIED WITH THE BUILDING. THEIR SINGLE COMPLAINT HAS TO DO WITH THE OFFICE WINDOWS. THE WINDOWS ARE DOUBLE GLAZED, HOWEVER THE FRAMES ARE EXTRUDED ALUMINUM, WITHOUT A THERMAL BREAK. EXCESSIVE CONDENSATION AND ICE FORMS ON THE HORIZONTAL SECTIONS OF THE FRAME CAUSING WATER STAINS AROUND THE WOODWORK AROUND THE ALUMINUM.

THERE ARE NO COMPLAINTS ABOUT AIR QUALITY IN THE PRODUCTION SPACE. THE WALLS ARE PARTIALLY INSULATED WITH UREA FORMALDEHYDE FOAM, AND THERE IS NO VAPOUR BARRIER ON THE INTERIOR SURFACE OF THE CONCRETE BLOCK WALL.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-30

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE BUILDING IS MORE THAN FIFTEEN YEARS OLD. THE CURRENT OCCUPANT USES THE BUILDING AS A PRINTING SHOP, SPECIALIZING IN PRINTING ON BOXES, DISPLAY CONTAINERS AND GENERAL PACKAGING. THE BUILDING IS OPERATED FOR A SINGLE OR A DOUBLE SHIFT AS THE WORK LOAD VARIES.

STRUCTURE : THE BUILDING IS A MEDIUM SIZE, SINGLE STOREY STRUCTURE. THE GROUND FLOOR AREA IS 2,148 m^2, OF WHICH 395 m^2 IS OFFICE SPACE. THERE IS A 75m^2 STORAGE MEZZANINE ABOVE ONE SECTION OF THE OFFICE AREA. THE SHIPPING AREA IS A 58 m^2 ROOM, SEPARATED FROM THE PRODUCTION AREA BY BLOCK WALLS AND A PLASTIC STRIP CURTAIN.

THE FLAT ROOF IS A BUILT UP MEMBRANE ON RIGID INSULATION. IT REQUIRES REPAIR ANNUALLY. IN AN ATTEMPT TO WATERPROOF THE EXISTING MEMBRANE, THE GRAVEL WAS SCRAPED FROM THE ROOF AND THE ENTIRE ROOF AREA WAS COVERED WITH A FIBERGLASS SCREEN AND LOW MELTING TEMPERATURE ASPHALT. THERE IS NO GRAVEL COVERING. THE ROOF STRUCTURE IS A STEEL DECK SUPPORTED ON OPEN WEB STEEL JOISTS ON STEEL BEAMS AND COLUMNS. THE STEEL DECK IS 4.7 m ABOVE THE SLAB.

THE WALLS ARE LOADBEARING CONCRETE BLOCK PAINTED ON THE EXTERIOR. THE OFFICE WALLS ARE CLAD WITH BRICK. THE WALLS ARE NOT INSULATED.

SYSTEMS : BOTH THE OFFICES AND THE PRODUCTION AREA ARE HEATED AND COOLED BY ROOF MOUNTED FORCED AIR UNITS. IN THE PRINTING PROCESS THE PAPER MUST BE KEPT WITHIN A NARROW RANGE OF TEMPERATURES (±21°C) AND HUMIDITY (±40% RH) OR ELSE THE AUTOMATIC STOCK FEED FOR THE PRINTERS WILL NOT WORK. THEREFORE NIGHT SETBACK CANNOT BE USED. THE COARSE FILTERS IN THE FORCED AIR SYSTEMS ARE CLEANED EVERY TWO WEEKS, THE FINE FILTERS ARE CLEANED EVERY FOUR MONTHS.

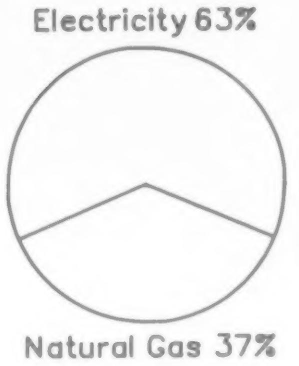
THERE IS ONE EXHAUST FAN IN THE SOUTH EAST PRODUCTION AREA, AND TWO EXHAUSTERS ON ONE PIECE OF PROCESS DRYING EQUIPMENT. THERE IS NO MAKE UP AIR EQUIPMENT.

LIGHTING IS FLUORESCENT THROUGHOUT. THERE ARE NO AUTOMATIC CONTROLS IN THE LIGHTING SYSTEM.

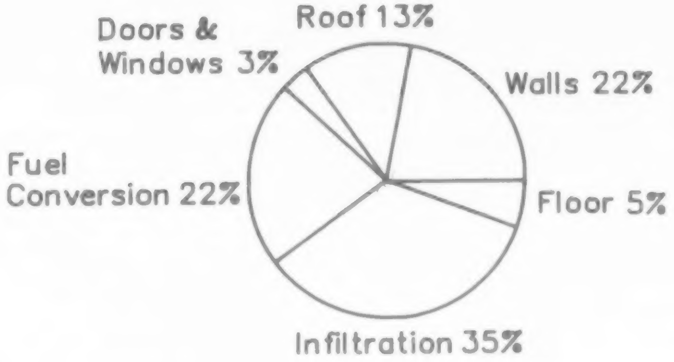
ENERGY : NATURAL GAS PROVIDES ONLY SPACE HEATING. THE 1981/82 HEATING SEASON CONSUMPTION WAS 2,575 GJ, \$10,316, 1.20 GJ/m^2 YEAR, 0.26 GJ/m^3 YEAR. ELECTRICITY IS USED FOR LIGHTING, COOLING, MOTORS, AND PRINTING PRESSES. THE 1981/82 CONSUMPTION WAS 1,679 GJ, \$17,271 0.78 GJ/m^2 YEAR.

Building #30

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE NATURAL VENTILATION RATE OF 1.20 AIR CHANGES PER HOUR IS THE MOST SIGNIFICANT TYPE OF HEAT LOSS. IT ACCOUNTS FOR 47% OF THE ANNUAL HEATING BILL. THE ONLY OTHER IMPORTANT AREAS OF HEAT LOSS ARE THE WALLS (27%) AND THE ROOF (19%). THE HIGH AIR CHANGE RATE MAY BE ASSOCIATED WITH THE SHIPPING AREA, SINCE THE DOOR DOES NOT HAVE TRAILER SEALS AND IT IS LOCATED IN AN AREA THAT ACTS LIKE A WINDSCOOP FOR THE PREVAILING WINTER WINDS, FORCING COLD AIR INTO THE BUILDING. FORCED VENTILATION DOES NOT APPEAR TO BE A SIGNIFICANT CONTRIBUTOR TO THE HEAT LOAD.

THE COST OF ELECTRICITY IS ALMOST DOUBLE THAT OF NATURAL GAS, WHICH IS NOT UNEXPECTED CONSIDERING THE QUALITY OF LIGHT LEVELS, THE AIR CONDITIONING LOAD, AND THE EQUIPMENT OPERATION (OFTEN FOR TWO SHIFTS PER DAY). NOTE, HOWEVER, THAT IN TERMS OF ENERGY CONSUMED, ELECTRICAL CONSUMPTION IS ONLY 66% THAT OF NATURAL GAS.

EVEN THOUGH EXTENSIVE REPAIR WORK HAS BEEN DONE, THE ROOF REQUIRES ANNUAL MAINTENANCE. BECAUSE OF CONTINUING LEAKAGE PROBLEMS SOME OF THE MORE VALUABLE PRINTING EQUIPMENT AND STOCK HAVE TO BE PROTECTED WITH PLASTIC SHEETS BELOW THE ROOF DECK.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-31

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE PREVIOUS OCCUPANT AND WAS USED TO MANUFACTURE WOOD STAIRS. THE CURRENT OWNER/OCCUPANT DOUBLED THE OFFICE AREA AND USES THE BUILDING AS A DISTRIBUTION CENTRE FOR BOOKS AND MAGAZINES. THEY HAVE BEEN IN THE BUILDING FOR TWO YEARS. THIS IS A ONE STOREY BUILDING. THE TOTAL FLOOR AREA IS 2,021 m^2, OF WHICH 273 m^2 IS OFFICE SPACE.

STRUCTURE : THE BUILDING APPEARS TO BE BETWEEN 10 TO 20 YEARS OLD. THE EXTERIOR CONCRETE BLOCK WALLS ARE LOAD BEARING, AS IS THE BLOCK WALL AT THE CENTER OF THE BUILDING. THE ROOF STRUCTURE COMPRISES STEEL JOISTS ON INTERIOR STEEL BEAMS AND COLUMNS. THE ROOF IS A BUILT UP MEMBRANE ON 38 mm OF RIGID INSULATION.

THE SHIPPING/RECEIVING AREA IS SEPARATED FROM THE PACKING AND SHOWROOM AREAS BY EITHER WOOD FRAME OR CONCRETE BLOCK WALLS, AND LARGE DOORS.

ONLY THE OFFICE WALLS ARE INSULATED. THE CONCRETE BLOCK WALLS ARE PAINTED ON THE EXTERIOR SURFACE IN AN ATTEMPT TO REDUCE AIR INFILTRATION.

SYSTEMS : THE OFFICE AREA IS HEATED AND COOLED BY TWO FORCED AIR UNITS WHICH ARE MOUNTED ON THE ROOF. THESE UNITS DO NOT PROVIDE FRESH AIR TO THE BUILDING. THE NORTH HALF OF THE PRODUCTION AREA IS HEATED BY A FORCED AIR UNIT MOUNTED ON THE ROOF. THIS UNIT HAS MOTORIZED DAMPERS THAT CAN BE POSITIONED TO PROVIDE 100% OUTSIDE AIR TO PRESSURIZE THE SPACE. THIS UNIT WAS INSTALLED BY THE PREVIOUS OCCUPANT. THE CURRENT OCCUPANTS DRAW THE RETURN AIR FROM THE BUILDING SINCE THE INSIDE AIR IS CLEAN. THE SOUTH HALF OF THE PRODUCTION AREA IS THE SHOWROOM AND SHIPPING AREAS WHICH ARE HEATED BY UNIT HEATERS MOUNTED JUST BELOW THE CEILING JOISTS. THERE IS AUTOMATIC NIGHT TEMPERATURE SETBACK FOR THE PRODUCTION AREA, BUT NOT FOR THE OFFICE AREA.

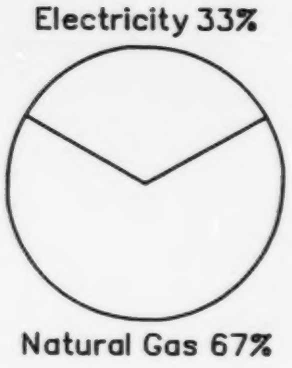
ARTIFICIAL LIGHTING IS FLUORESCENT THROUGHOUT. AN AUTOMATIC TIMER CONTROLS THE EXTERIOR LIGHTS, BUT THE INTERIOR LIGHTS ARE MANUALLY SWITCHED OFF AT NIGHT.

ENERGY : NATURAL GAS IS USED FOR ALL SPACE HEATING. THE TOTAL GAS CONSUMPTION OVER THE 1981 -82 HEATING SEASON WAS 2212 GJ, $9413, 1.09 GJ/$m^2$ YEAR, 0.208 GJ/m^3 YEAR.

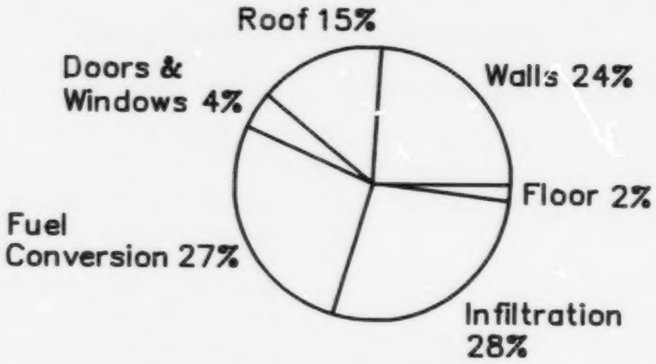
THE MAJOR ELECTRIC LOAD IS LIGHTING. OTHER USES INCLUDE OFFICE SPACE COOLING , OFFICE EQUIPMENT AND SOME SMALL EQUIPMENT IN THE PRODUCTION AREAS. CONSUMPTION FOR THE 1981-82 HEATING SEASON WAS 415 GJ, $4744, 0.21 GJ/$m^2$ YEAR.

Building #31

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE ANNUAL COST OF SPACE HEATING IS MUCH MORE THAN THAT FOR LIGHTING IN THIS BUILDING. THE MAJOR CONTRIBUTOR TO THE HEATING BILL IS NATURAL VENTILATION, THE RATE BEING 0.81 AIR CHANGES PER HOUR. AIR LEAKAGE ACCOUNTS FOR 39% OF THE TOTAL WHILE THE WALLS (33%), AND ROOF (21%) ACCOUNT FOR THE BULK OF THE REMAINDER.

THAT AVERAGE AIR CHANGE RATE IS 50% HIGHER THAN THE AVERAGE FOR COMPARABLE BUILDINGS YET THE SPACE HEATING ENERGY CONSUMPTION INDEX IS LESS THAN 10% HIGHER THAN THE AVERAGE FOR OTHER BUILDINGS THAT WE HAVE EXAMINED.

THE NORTH WALL IS UNINSULATED CONCRETE BLOCK. IT WAS RECENTLY PAINTED ON THE EXTERIOR IN ORDER TO REDUCE AIR LEAKAGE. WHILE THIS SEEMS TO HAS BEEN SOMEWHAT SUCCESSFUL, THE PRODUCTION AREA ADJACENT TO THE NORTH WALL IS STILL COOL ON COLD, WINDY DAYS.

THE FORCED AIR HEATING SYSTEM IN THE NORTH PRODUCTION AREA HAS DISTRIBUTION DUCTWORK AT THE CEILING. THE AIR IS BLOWN DOWN AT HIGH VELOCITY, AND SINCE IT IS COOLED ENROUTE, IT BECOMES A DRAFT IN SOME AREAS.

FILE NUMBER	: 20601-32
BUILDING TYPE	: WAREHOUSE
BUILDING NAME	: CONFIDENTIAL
BUILDING ADDRESS	: CONFIDENTIAL
LOCATION	: BRAMPTON, ONTARIO

OCCUPANCY : THE OVERALL FACILITY WAS CUSTOM DESIGNED BY THE OWNER/OCCUPANT'S OWN ENGINEERING DIVISION TO SUIT THEIR SPECIFIC REQUIREMENTS FOR THE AUTOMATED STORAGE AND RETRIEVAL OF CONSUMER GOODS. THE COMPLEX WAS BUILT IN THREE STAGES (1973, 1976 AND 1978). THE COMPANY IS A VERY LARGE, WELL RUN, PROFIT SHARING CORPORATION INVOLVED IN THE RETAILING OF HARDWARE, AUTOMOTIVE AND OTHER NON-PERISHABLE PRODUCTS. THIS NINE BUILDING COMPLEX IS THEIR MAIN DISTRIBUTION CENTER AND IS ONE OF THE LARGEST FACILITIES OF ITS KIND IN THE WORLD.

STRUCTURE : THIS LARGE COMPLEX IS COMPOSED OF TWO TYPES OF SPACE; LOW STORAGE/RETRIEVAL AREAS WITH A CLEAR HEIGHT OF 10 m AND THREE TALL AUTOMATED STORAGE/RETRIEVAL AREAS WITH A CLEAR HEIGHT OF EITHER 24 m or 28 m. THE GROUND FLOOR AREA IS 133,238 m^2. THE OFFICE AREA COMPRISES LESS THAN 3% OF THE TOTAL. MOST ADMINISTRATIVE WORK IS DONE AT THE HEAD OFFICE LOCATED ELSEWHERE. DESPITE THE STAGED CONSTRUCTION, THE FACILITY IS CONSISTENT IN CONSTRUCTION. THE ROOF IS AN INSULATED, FLAT B.U.R. MEMBRANE ON A STEEL DECK, HOWEVER, THE ORIGINAL BUILDING HAS HAD 40 mm OF EXTRUDED POLYSTYRENE TYPE IV ADDED ABOVE THE EXISTING MEMBRANE, AN AREA WHICH ORIGINALLY HAD 25 mm OF INSULATION. THE ROOF STRUCTURE CONSISTS OF EITHER STEEL TRUSSES OR OPEN WEB STEEL JOISTS SUPPORTED ON STEEL BEAMS AND COLUMNS. THE EXTERIOR WALLS ARE NON-LOAD BEARING. TYPICALLY THE WALLS ARE INSULATED WITH CORRUGATED METAL CLADDING ABOVE A LOWER WALL SECTION OF SPLIT-FACE CONCRETE BLOCK OR CAST-IN-PLACE CONCRETE.

THE SHIPPING/RECEIVING AREAS ARE NOT SEPARATED FROM THE REST OF THE BUILDING. THIS IS OF PARTICULAR SIGNIFICANCE SINCE TRUCKS ARE BROUGHT INTO THE BUILDING FOR LOADING OR UNLOADING, REQUIRING THAT SHIPPING DOORS BE FULLY OPEN QUITE OFTEN. ALSO, THE COLD TRAILERS AND THEIR CONTENTS WILL COOL THE SHIPPING AREA. ONE SHIPPING AREA IS LOCATED AT THE NORTH SIDE OF THE BUILDING WHILE THE OTHER IS ON THE SOUTH SIDE. THIS ARRANGEMENT TENDS TO INCREASE THE RATE OF AIR FLOW THROUGH THE BUILDING.

SYSTEMS : MOST OF THE SPACE HEATING IS PROVIDED BY DIRECT FIRED NATURAL GAS RADIANT HEATERS. THE SHIPPING AREAS AND THE OFFICES ARE HEATED BY GAS FIRED FORCED AIR FURNACES. THE OCCUPANTS REPORT THAT WHEN THE SHIPPING DOORS ARE OPEN ON A COLD DAY, THE FURNACES THERE DO NOT MAINTAIN THE SET TEMPERATURE. THERE IS NO THERMOSTAT SETBACK.

THE OFFICE AREA ROOF-TOP UNITS PROVIDE BOTH HEATING AND COOLING. THE COMPUTER ROOM HAS ITS OWN HEATING/COOLING SYSTEM.

THE WAREHOUSE AND SHIPPING AREAS ARE ILLUMINATED BY EFFICIENT H.I.D. FIXTURES MOUNTED JUST BELOW THE ROOF JOISTS. THE OFFICE LIGHTING IS FLUORESCENT. EXTERIOR LIGHTING IS H.I.D. THERE IS TYPICALLY ONE EXTERNAL LIGHT ABOVE EACH SHIPPING DOOR, AND ALSO SEVERAL LAMP STANDARDS IN THE PARKING LOT.

THE EXHAUST SYSTEMS ARE ONLY OPERATED IN CASE OF FIRE, OR TO EXPEL TRUCK FUMES IN THE SHIPPING AREA. THERE ARE NO PROPANE FORK LIFT TRUCKS (ie. ALL ELECTRIC). ALL MATERIALS HANDLING IS DONE VIA A VERY ORGANIZED, MOSTLY AUTOMATIC SYSTEM INVOLVING COMPUTER CO-ORDINATION, MULTI-LEVEL CONVEYORS, AND REMOTE CONTROLLED CARTS THAT WILL TAKE A PRODUCT FROM STORAGE TO THE TRUCK WITH A MINIMUM OF MANUAL HANDLING.

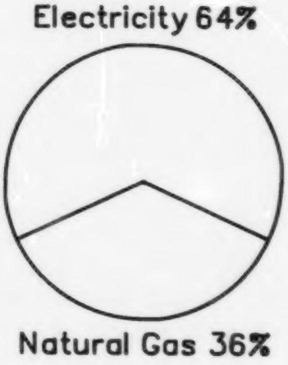
HOT WATER (DOMESTIC USE) IS HEATED ELECTRICALLY. THE TANKS ARE LOCATED ABOVE WASHROOMS AROUND THE BUILDING. CLOSE TO THE OFFICE AREAS, THERE IS A KITCHEN AND CAFETERIA THAT PROVIDES FULL COURSE MEALS.

ENERGY : NATURAL GAS PROVIDES ALL SPACE HEATING. THE SPACE HEATING ENERGY IN 1982 WAS 75,842 GJ, $298,455, 0.57 GJ/m^2 YEAR, 0.031 GJ/m^3 YEAR.

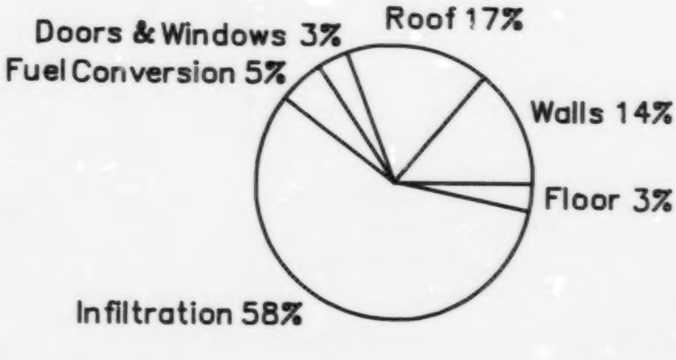
ELECTRICITY PROVIDES ALL LIGHT AND PROCESS ENERGY, AS WELL AS OPERATING THE EXTENSIVE COMPUTER SYSTEM. ELECTRICAL CONSUMPTION IS RELATIVELY HIGH IN THIS BUILDING, 56,105 GJ, $533,468, 0.42 GJ/m^2 YEAR. THIS IS POSSIBLY DUE TO THE ELECTRIC CONVEYOR SYSTEMS.

Building #32

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : AN ESTIMATE OF THE RELATIVE EFFECT OF THE VARIOUS CONTRIBUTORS TO HEAT LOSS HAS BEEN MADE. THE ESTIMATED NATURAL AIR LEAKAGE RATE IS NEAR THE LOW END OF THE USUAL RANGE, 0.26 AIR CHANGES PER HOUR, BUT STILL IT ACCOUNTS FOR THE MAJORITY OF THE ANNUAL HEATING BILL (63%). IT IS PROBABLE THAT THE SHIPPING DOORS ARE OPEN FOR EXTENSIVE PERIODS DURING THE WINTER (17 HOURS/DAY, FOR 4 DAYS/WEEK AND 12 HOURS/DAY FOR 1 DAY/WEEK).

THE ROOF ACCOUNTS FOR 17% OF THE HEAT LOSS,AND THE WALLS ACCOUNT FOR 13.5%. THE RATIO OF ROOF AREA TO WALL AREA IS ABOUT 2.7 WHEREAS THE RATIO OF ENERGY LOSS IS 1.5, INDICATING THAT ON A PER UNIT AREA BASIS THE WALLS ARE RELATIVELY MORE SIGNIFICANT CONTRIBUTORS TO ENERGY USE.

THE COST OF ELECTRICITY ($533,468) FAR EXCEEDS THAT FOR NATURAL GAS SPACE HEATING ($298,455). THE COMPANY'S CURRENT ENERGY CONSERVATION PROGRAM IS DIRECTED TOWARDS REDUCING ELECTRICAL CONSUMPTION. SINCE THE LOCAL ELECTRIC UTILITY IS PROVIDING A 15 MINUTE INTERVAL READING OF KW, KVAR, KVA AND POWER FACTOR THE EFFECTS OF ENERGY CONSERVATION MEASURES ARE IMMEDIATELY APPARENT. CURRENT CONSERVATION MEASURES INCLUDE NEW SWITCHING SCHEDULES FOR EXTERIOR LIGHTS AND SIGNS, INTERIOR LIGHTS, AND INTERNAL EQUIPMENT (NOW SWITCHED OFF AT LUNCH HOUR, ETC).

THE COST OF SPACE HEATING MAY BE REDUCED BY ADDRESSING INFILTRATION INTO THE SHIPPING AREAS. THE TOTAL COST ASSOCIATED WITH INFILTRATION WAS ESTIMATED TO BE $191,011 IN 1982. PREDICTING THE EFFECTS OF CONSERVATION MEASURES SUCH AS ADDING A WALL BEHIND THE TRAILERS (WITH OVERHEAD DOORS AND TRUCK SEALS), IS MOST DIFFICULT SINCE THE AIR FLOW RATES ARE QUITE UNPREDICTABLE. AS WITH THE CURRENT PROGRAM OF ELECTRICAL CONSERVATION MEASURES, ANY HEATING CONSERVATION MEASURE SHOULD BE TESTED INEXPENSIVELY BEFORE MAJOR ACTION IS TAKEN. THIS COULD INVOLVE SEALING THE SHIPPING AREA WITH POLYETHYLENE AND DOING TRACER GAS TESTS ON A WEEKEND WITH THE DOORS OPEN AND CLOSED. POTENTIAL SAVINGS COULD BE BETTER ESTIMATED WITH SUCH INFORMATION.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-33

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : GUELPH, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE OWNER/OCCUPANT IN 1976. THE COMPANY MANUFACTURES PLASTIC MOULDING EQUIPMENT. THERE ARE TWO OFFICE AREAS: A DESIGN AND SALES OFFICE ADJACENT TO THE PRODUCTION AREA AND A PRODUCTION OFFICE ON A MEZZANINE FLOOR OVERLOOKING THE MANUFACTURING AREA.

THERE IS ONE SHIFT PER DAY IN THE OFFICE AREA, AND TWO SHIFTS IN THE PRODUCTION AREA.

STRUCTURE : THIS IS A ONE STOREY BUILDING WITH A TOTAL FLOOR AREA OF 3,473 m^2. MOST OF THIS AREA IS MANUFACTURING SPACE, HOWEVER THE FRONT OFFICE COMPRISES 665 m^2 OR 19% OF THE TOTAL. THESE AREAS DO NOT INCLUDE A 210 m^2 MEZZANINE OFFICE SPACE ABOVE THE ELECTRICAL SHOP. THE PRODUCTION AREA ROOF DECK IS 7.9 m ABOVE THE FLOOR SLAB. THE OFFICE AREA ROOF DECK IS 3.8 m ABOVE THE FLOOR SLAB. THE BUILDING VOLUME IS 24,944 m^3.

THE ROOF IS SOMEWHAT ATYPICAL WITH THE WATERPROOF, BUILT-UP ROOFING MEMBRANE BEING LOCATED BENEATH THE RIGID INSULATION. THE 50 mm TYPE IV POLYSTYRENE RIGID FOAM BOARD IS NOT ADHERED TO THE MEMBRANE, BUT IS PROTECTED AND BALLASTED WITH SOME 30 mm OF WASHED STONE.

THE WALLS ARE NON-LOADBEARING PRECAST CONCRETE PANELS INSULATED WITH 50 mm RIGID INSULATION AT THE MIDDLE OF EACH PANEL. THE MAIN STRUCTURE CONSISTS OF STEEL BEAMS AND COLUMNS THROUGHOUT SUPPORTING OPEN WEB STEEL ROOF JOISTS. THE OFFICE WALLS ARE SIMILAR BUT THE PRECAST PANELS ARE FINISHED WITH METAL FURRING AND DRYWALL ON THE INTERIOR. THE TYPICAL OFFICE CEILING IS ACCOUSTICAL TILE. THIS TYPE OF CONSTRUCTION, IN CONJUNCTION WITH THE AIR SEALING DETAILS, SHOULD PRODUCE A RELATIVELY AIRTIGHT BUILDING.

THE WINDOWS ARE SEALED DOUBLE GLAZING IN NON-OPENABLE ALUMINUM FRAMES. THERE ARE SKYLIGHTS IN THE VESTIBULES BETWEEN THE OFFICE AREAS AND THE PRODUCTION SPACE. THE SKYLIGHTS IN THE PRODUCTION AREA ARE DOUBLE GLAZED PLASTIC DOMES. IN THE CASE OF A FIRE, THEY WOULD MELT AND PURGE SMOKE.

THERE ARE THREE ROLLING METAL SHIPPING DOORS. SINCE THE COMPANY MANUFACTURES LARGE, HEAVY MACHINERY, THERE IS ONE SHIPPING DOCK THAT ALLOWS A 12 m TRAILER TO BE BROUGHT INTO THE BUILDING. THE 3.7 m x 4.3 m DOOR ON THE EAST WALL WAS TESTED TO DETERMINE AIR LEAKAGE. THE TEST PROCEDURE AND EQUIPMENT WAS DEVELOPED BY THE BUILDING ENGINEERING GROUP. THE INTENT OF THE TEST IS TO ESTABLISH THE PERFORMANCE OF DOORS AFTER INSTALLATION AND USE, AND THE TEST PROCEDURE IS GENERALLY SIMILAR TO ASTM-E283. THESE DOORS ARE RELATIVELY LEAKY AND HAVE LITTLE THERMAL RESISTANCE.

SYSTEMS : THE MAIN OFFICE AREA HAS TWO HEATING SYSTEMS. PERIMETER ELECTRIC CONVECTOR BASEBOARD UNITS NEAR THE FLOOR SUPPLEMENT THE GAS FIRED FORCED AIR UNITS MOUNTED ON THE ROOF. THESE UNITS ALSO INCORPORATE AIR CONDITIONING. THE MEZZANINE OFFICE AREA IS HEATED AND COOLED BY A SIMILAR FORCED AIR UNIT ON THE ROOF. THE PRODUCTION AREA IS HEATED BY GAS FIRED RADIANT UNITS MOUNTED 4 m TO 5 m ABOVE THE FLOOR. THESE ARE DIRECT FIRED UNITS THEREFORE TWO EXHAUST UNITS HAVE BEEN INSTALLED TO EXPEL THE PRODUCTS OF COMBUSTION. SUPPLEMENTAL GAS FIRED UNIT HEATERS ARE ALSO MOUNTED BELOW THE ROOF JOISTS NEAR THE SHIPPING AREAS. AN AUTOMATIC SETBACK DEVICE LOWERS THE PRODUCTION AREA TEMPERATURE ON THE WEEKENDS ONLY.

SINCE THERE ARE EXHAUST UNITS ASSOCIATED WITH THE SPRAY PAINTING BOOTH AND THE SHIPPING AREA, THERE IS A GAS FIRED MAKE-UP AIR UNIT ON THE ROOF. THERE ARE TWO BURNER SECTIONS IN THIS UNIT, AND THEY APPEAR TO BE CONNECTED IN SERIES. THIS UNIT WAS NOT OPERATING ON THE SURVEY DATE, THEREFORE THE AIRFLOW AND HEAT OUTPUT WERE NOT MEASURED.

LIGHTING IS EITHER INCANDESCENT SPOTLAMPS OR FLUORESCENT FIXTURES IN THE OFFICE AREA, AND MERCURY VAPOUR LAMPS IN THE PRODUCTION AREA. SKYLIGHTS PROVIDE A SIGNIFICANT AMOUNT OF NATURAL LIGHT. THE HIGHEST LIGHT LEVEL WAS OBSERVED IN THE POOL OF LIGHT PRODUCED BY THE SKYLIGHT (200 FOOT CANDLES), HOWEVER, EVEN TRANSMITTED DIFFUSE RADIATION REGISTERED 120 fc NEAR EACH SKYLIGHT. THE LOWEST LIGHT LEVEL WAS 30 fc AT A LOCATION FURTHEST FROM ANY LIGHTS OR SKYLIGHTS.

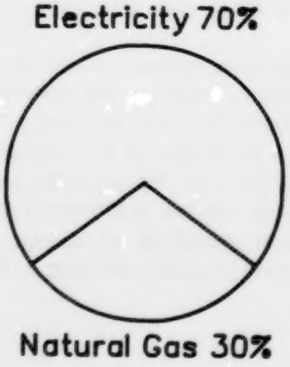
HOT WATER HEATING IS PROVIDED BY ONE ELECTRICALLY HEATED TANK.

PROCESS EQUIPMENT INCLUDES GENERAL MACHINE SHOP EQUIPMENT, A SPRAY PAINT BOOTH WITH EXHAUST FANS, AND A LARGE OVERHEAD CRANE ON STEEL RAILS/BEAMS SUPPORTED ON THE STRUCTURAL STEEL COLUMNS.

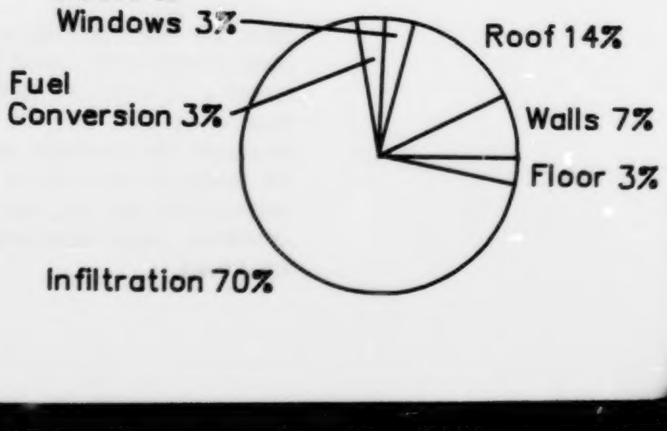
ENERGY : ENERGY CONSUMPTION DURING THE 1982/83 HEATING SEASON WAS USED AS THE BASIS FOR OUR ANALYSIS. THE GAS CONSUMPTION FOR SPACE HEATING AND MAKE-UP AIR HEATING WAS 4,185 GJ, $19,289, 1.21 GJ/m^2 YEAR, 0.17 GJ m^3 YEAR. THE ELECTRIC CONSUMPTION FOR SUPPLEMENTAL SPACE HEATING, OFFICE AIR CONDITIONING, INTERIOR AND EXTERIOR LIGHTING, DOMESTIC HOT WATER HEATING, AND ALL PROCESS ENERGY FOR THE SAME PERIOD WAS 3,097 GJ, $44,070, 0.89 GJ/m^2 YEAR.

Building #33

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : NATURAL GAS CONSUMPTION IS HIGHER THAN WOULD BE EXPECTED FOR AN INSULATED AND RELATIVELY AIRTIGHT BUILDING. THIS MAY BE ATTRIBUTED TO THE NATURE OF THE SHIPPING/RECEIVING AREA AND THE OPERATION OF THE MAKE-UP AIR UNIT ON THE ROOF.MOST OF THE MATERIALS SHIPPED AND RECEIVED ARE LARGE AND BULKY AND THEREFORE ARE TRANSPORTED ON FLAT BED TRAILERS. THE LOADING AREA IS DESIGNED TO ALLOW THE TRAILER TO BE BROUGHT INTO THE BUILDING. HOWEVER, THE TRUCK CAB PROTRUDES THROUGH THE DOOR OPENING, LEADING TO HIGH INFILTRATION OR EXFILTRATION AND UNCOMFORTABLE CONDITIONS AS THE HEATING SYSTEM FOR THIS AREA IS NOT CAPABLE OF HANDLING THIS AMOUNT OF AIR LEAKAGE. AS PART OF NEW CONSTRUCTION WORK THAT WILL DOUBLE THE SIZE OF THE PLANT, THE LOADING AREA HAS BEEN LENGTHENED TO SOLVE THIS PROBLEM.

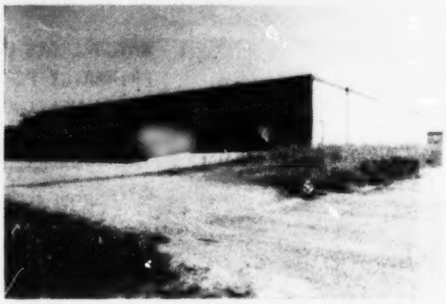
A SECOND REASON FOR THE HIGH CONSUMPTION OF NATURAL GAS MIGHT INVOLVE THE DESIGN AND OPERATION OF THE MAKE-UP AIR UNIT ON THE ROOF. IT APPEARS TO BE DESIGNED TO PRESSURIZE THE BUILDING SINCE IT SUPPLIES ALMOST 1,500 LITRES/SEC MORE AIR TO THE BUILDING THAN APPEARS TO BE REMOVED BY THE EXHAUST SYSTEMS (BASED ON THE OCCUPANT'S KNOWLEDGE). AS PREVIOUSLY MENTIONED, BOTH THE BLOWER UNITS AND THE GAS BURNER SECTIONS ARE INSTALLED IN SERIES, NOT PARALLEL. THIS CAN LEAD TO VERY HIGH AIR VELOCITIES AND POOR HEAT TRANSFER AT THE HEAT EXCHANGERS (THE UNITS ARE INDIRECT FIRED). THE HEAT TRANSFER WILL BE LESSENED BY THE HIGH AIR FLOW RATE, BUT MORE SIGNIFICANTLY, THE AIR PASSING THROUGH THE SECOND HEAT EXCHANGER WILL BE PRE-WARMED, IMPAIRING THE HEAT TRANSFER.THE SECOND HEAT EXCHANGER WILL TEND TO OPERATE AT A HIGHER TEMPERATURE THAN THE FIRST, AND THE EFFICIENCY OF THE UNIT WILL TEND TO BE LOWER. HOWEVER, THE CONTROLS ARE CERTAINLY THE MORE SIGNIFICANT PROBLEM. THE ORIGINAL CONTROL SWITCHED THE UNIT ON WITH THE EXHAUST UNITS. IT IS NOW SWITCHED ON CONTINUOUSLY DURING THE TWO SHIFTS. THERE IS NO INFORMATION ON HOW THE BURNERS ARE CONTROLLED, HOWEVER, IF THEY ARE BOTH ON WHENEVER THE UNIT IS SWITCHED ON, THIS WILL CONSTITUTE A SIGNIFICANT NATURAL GAS LOAD WHICH DOES NOT VARY DIRECTLY WITH THE OUTDOOR CONDITIONS.

FOR THESE REASONS, OUR PROCEDURE CANNOT ESTIMATE AN AVERAGE NATURAL VENTILATION RATE FOR THIS BUILDING. THE VENTILATION RATE THAT MATCHES THE 4,185 GJ GAS CONSUMPTION IS 1.46 AIR CHANGES PER HOUR. A MORE REASONABLE AIR CHANGE RATE OF 0.6 ACPH (NATURAL) AND 0.15 ACPH (MECHANICAL) WOULD LEAD TO 1,376 GJ OF NATURAL GAS CONSUMPTION DURING THE 81-82 WINTER. THIS QUANTITY OF GAS WOULD HAVE COST \$6,340, OR \$12,947 LESS THAN ACTUALLY SPENT. MODIFICATIONS TO THE MECHANICAL SYSTEMS AND THE OPERATION OF THE DOORS SHOULD BE CONSIDERED. EVEN AT 0.75 AIR CHANGES PER HOUR, THE AIR LEAKAGE RATE IS THE MOST SIGNIFICANT MODE OF HEAT LOSS (58%).

THE DIRECT FIRED, NATURAL GAS RADIANT HEATING SYSTEM IN THE PRODUCTION AREA DOES NOT PROVIDE EVEN HEAT THROUGHOUT THE SPACE. THERE IS ONE RADIANT HEATER PER BAY, WHICH ACTS AS A POINT SOURCE. DUE TO THE CONCENTRATING EFFECT OF THE REFLECTOR, THE AREA DIRECTLY BELOW THE HEATERS CAN BE UNCOMFORTABLY HOT.

THE BUILDING IS IN A VERY EXPOSED LOCATION, AND SINCE THE WALLS ARE 8.0 m HIGH, THERE ARE PROBLEMS ASSOCIATED WITH WIND EFFECTS. HIGH VELOCITY WIND HAS SHIFTED SOME OF THE GRAVEL COVERING THE INSULATION BOARD ON THE ROOF AT THE WEST AND EAST WALLS, AND PARTICULARLY AT THE NORTH WEST CORNER OF THE PLANT ROOF, WHERE WIND SCOURING HAS REMOVED THE STONE AND 0.6 m^2 OF ROOF INSULATION. THE BUILT-UP ROOF MEMBRANE IS EXPOSED AT THIS LOCATION, HOWEVER MEMBRANE DETERIORATION IS NOT EVIDENT. THE WIND SCOURING AT THE NORTHWEST CORNER IS NOT AS SEVERE.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY



FILE NUMBER : 20601-34

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : WATERLOO, ONTARIO

OCCUPANCY : THIS BUILDING WAS BUILT BY, BUT NEVER OCCUPIED BY, THE CURRENT OWNER. THE CONSTRUCTION DATE IS UNKNOWN, HOWEVER, THE BUILDING APPEARS TO BE SOME TWENTY YEARS OLD. A COMPLETE RECORD OF THE USE OVER THE YEARS IS NOT AVAILABLE. THE CURRENT OCCUPANT LEASES THE ENTIRE BUILDING. IT IS USED FOR THE MANUFACTURE AND STORAGE OF WOOD FURNITURE, PRIMARILY CHAIRS. THE OFFICE AREA IS USED FOR ADMINISTRATIVE PURPOSES. THE DESIGN WORK IS DONE ELSEWHERE. SINCE THE BUILDING WAS DESIGNED FOR USE BY TWO DIFFERENT TENANTS, THERE IS A SECOND OFFICE AREA. THIS AREA IS CURRENTLY UNUSED AND UNHEATED. THE BUILDING IS OCCUPIED 8½ HOURS PER DAY FOR FOUR DAYS PER WEEK, AND FOR FOUR HOURS ON FRIDAYS.

STRUCTURE : THIS IS A ONE STOREY BUILDING WITH A TOTAL FLOOR AREA OF 2,197 m^2. ALTHOUGH THE BUILDING WAS ORIGINALLY AN UNDIVIDED SPACE THERE ARE NOW INTERNAL CONCRETE BLOCK WALLS THAT PARTITION TWO 436 m^2 AREAS . THESE SPACES RUN THE FULL DEPTH OF THE BUILDING. THE CURRENT OFFICE AREA IS APPROXIMATELY 40 m^2. THE OTHER 'OFFICE' AREA IS SOME 75 m^2. THE OCCUPANT PLANS TO CONVERT IT INTO A FURNITURE SHOWROOM.

THE ROOF IS SUPPORTED BY STEEL JOISTS ON STEEL BEAMS AND COLUMNS. THE CONCRETE BLOCK WALLS BETWEEN THE STEEL COLUMNS ARE NOT LOADBEARING. THE STEEL ROOF DECK IS 5.5 m ABOVE THE FLOOR SLAB. THE FLAT ROOF HAS A BUILT-UP MEMBRANE ON RIGID INSULATION.SINCE THE ARCHITECTURAL DRAWINGS ARE NOT AVAILABLE FOR THIS BUILDING, THE THICKNESS OF THE ROOF INSULATION IS NOT KNOWN. A COMMON THICKNESS OF 38 mm HAS BEEN USED IN THE CALCULATIONS.

THE PRODUCTION AREA RECEIVES SOME NATURAL LIGHT THROUGH VARIOUS AREAS OF TRANSLUCENT PLASTIC PANELS. MOST OF THE SHIPPING DOORS ARE ON THE WEST WALL. THE LOADING AREAS ARE NOT SEPARATED FROM THE REST OF THE BUILDING.

SYSTEMS : THE PRODUCTION AREA IS HEATED BY NINE GAS FIRED UNIT HEATERS SUSPENDED JUST BELOW THE OPEN WEB STEEL JOISTS. THE OFFICES HAVE ELECTRIC RESISTANCE BASEBOARD HEATERS, BUT THEY ARE RARELY USED. THE HEATERS IN THE UNUSED OFFICE AREA ARE SET AT THEIR LOWEST SETTING. THERE ARE NO AUTOMATIC CONTROLS ON THE HEATING SYSTEMS, HOWEVER, THE THERMOSTATS ARE MANUALLY SET TO A LOWER TEMPERATURE ON THE WEEKENDS. THE UNIT HEATER PILOT LIGHTS WERE SHUT OFF THIS SUMMER FOR THE FIRST TIME.

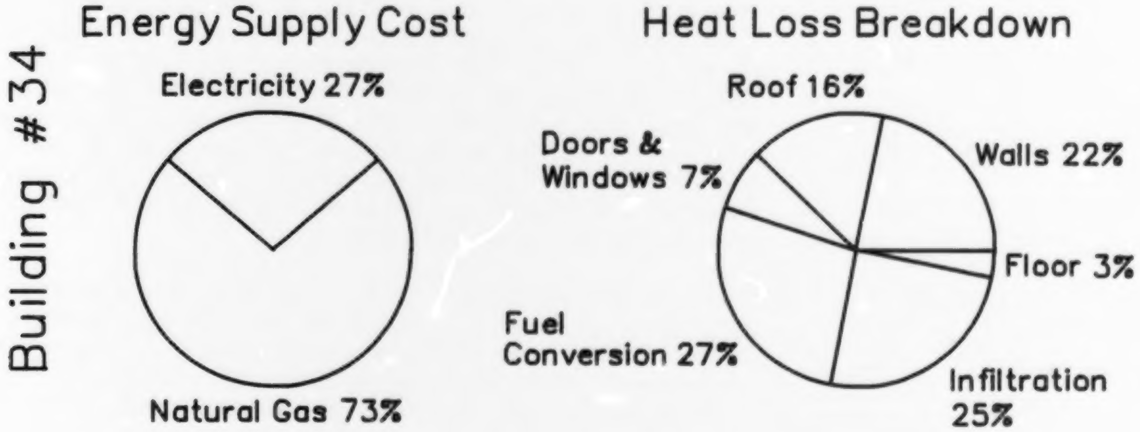
ARTIFICIAL LIGHTING IS FLUORESCENT THROUGHOUT. THE FIXTURES ARE 5.0 m ABOVE THE FLOOR EVEN THOUGH TYPICAL WORK AND STORAGE IS DONE BELOW 2.0 m.

THERE ARE NO AIR CONDITIONING OR EXHAUST SYSTEMS. PROCESS EQUIPMENT INCLUDES HEAVY-DUTY SAWS, PLANERS AND WOOD BENDING MACHINERY. A LARGE SAWDUST COLLECTION SYSTEM FILTERS THE PARTICLES OUT OF THE AIR AND

RECIRCULATES IT TO THE WOOD SHOP. DOMESTIC HOT WATER HEATING IS PROVIDED BY ONE ELECTRIC TANK.

ENERGY : NATURAL GAS ONLY PROVIDES SPACE HEATING. ELECTRICAL CONSUMPTION IS PRIMARILY FOR LIGHTING AND PROCESS EQUIPMENT, WITH SOME ATTRIBUTED TO SPACE HEATING AND DOMESTIC HOT WATER.

THE 1982 GAS CONSUMPTION WAS 3,009 GJ, $12,630, 1.37 GJ/$m^2$ YEAR, 0.25 GJ/m^3YEAR. THE 1982 ELECTRICITY CONSUMPTION WAS 405 GJ, $4,595, 0.18 GJ/$m^2$ YEAR.



COMMENTS : THE NATURAL GAS CONSUMPTION IS SOMEWHAT ABOVE THE NORM FOR SUCH A BUILDING. THIS MIGHT BE ATTRIBUTED TO A NATURAL VENTILATION RATE OF 0.60 AIR CHANGES PER HOUR THAT WOULD ACCOUNT FOR 34% OF THE ANNUAL HEAT LOSS. THE ROOF (23%) AND THE UNINSULATED WALLS (30%) COMPRISE THE BULK OF THE REMAINDER.

ALL THREE OF THE DOCK LEVELLERS ARE DAMAGED AND DO NOT OPERATE. THEY ARE AN OBVIOUS SOURCE OF AIR LEAKAGE. THE BUILDING IS IMMEDIATELY EAST OF A LARGE OPEN FIELD, AND THEREFORE IS FREQUENTLY EXPOSED TO STRONG WINDS. THERE IS PRONOUNCED WIND SCOURING AT THE NORTHWEST CORNER OF THE ROOF. HIGH VELOCITY AIR FLOW HAS REMOVED THE GRAVEL COVER OVER THE BUILT-UP ROOF MEMBRANE. THE MEMBRANE IS EXPOSED TO THE SUN AND THE ROOFING FELTS ARE DETERIORATED. THIS IS A POTENTIAL AREA OF WATER LEAKAGE. THERE IS EVIDENCE OF WIND SCOURING AT THE NORTH-EAST CORNER AS WELL, HOWEVER, THE MEMBRANE DOES NOT APPEAR TO BE AS SEVERELY DETERIORATED.

THE PERIMETER ROOF DRAIN AT THE NORTHWEST CORNER IS DAMAGED. IT NOW ALLOWS WATER TO POUR OVER THE WALL, WETTING THE CONCRETE BLOCK. THIS MAY LEAD TO DAMAGE OF THE BLOCK DUE TO FREEZE/THAW ACTION.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-35

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : KITCHENER, ONTARIO

OCCUPANCY : THE BUILDING HAS BEEN LEASED BY THE CURRENT OCCUPANT FOR SOME TEN YEARS. IT IS USED AS A DISTRIBUTION CENTER AND STORAGE SPACE FOR DRY GOODS FOR A LARGE RETAIL COMPANY. THERE ARE TWO SHIFTS OF TEN PEOPLE FIVE DAYS PER WEEK.

STRUCTURE : THIS IS A ONE STORY BUILDING WITH A TOTAL FLOOR AREA OF 5,290 m^2. THE ADMINISTRATION AREA IS LESS THAN 1% OF THE TOTAL FLOOR AREA. THE CEILINGS ARE 5.0 m HIGH EXCEPT IN THE OFFICE, WHERE A LOWER CEILING PROVIDES ROOM FOR A STORAGE MEZZANINE.

THE WAREHOUSE AREA APPEARS TO HAVE BEEN CONSTRUCTED IN TWO STAGES. THE SOUTH AREA'S STRUCTURE IS ENTIRELY STEEL JOISTS, BEAMS AND COLUMNS. MOST OF THE CONCRETE BLOCK EXTERIOR WALLS ARE NON-LOADBEARING. HOWEVER, THE CONCRETE BLOCK EXTERIOR WALLS IN THE NORTH AREAS DO SUPPORT THE ROOF AND ITS LOADS. THE INTERIOR STRUCTURE IS STEEL BEAMS AND COLUMNS THROUGHOUT. THE WALLS ARE UNINSULATED.

THE FLAT ROOF HAS A BUILT-UP MEMBRANE ON RIGID INSULATION. SINCE THE ARCHITECTURAL DRAWINGS ARE NOT AVAILABLE, THE THICKNESS OF THE ROOF INSULATION IS NOT KNOWN. A COMMON THICKNESS OF 38 mm HAS BEEN USED IN OUR CALCULATIONS.

MANY OF THE SHIPPING DOOR MASONRY OPENINGS THAT WERE ORIGINALLY 3 m x 3 m HAVE BEEN PARTIALLY FILLED WITH WOOD FRAMING AND A NEW DOOR TO SUIT A STANDARD 2.4 m x 3.0 m TRUCK TRAILER. SIX OF THESE DOORS HAVE TRAILER SEALS AROUND THE SMALLER OPENINGS. THERE IS A CONTINUOUS STRIP OF TRANSLUCENT PLASTIC NEAR THE CEILING ON THE EAST AND WEST WALLS.

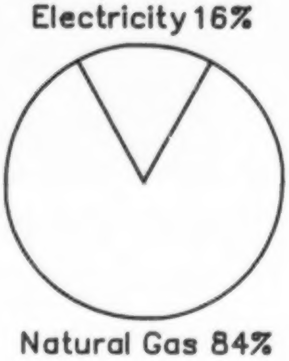
SYSTEMS : THE OFFICE IS HEATED BY A NATURAL GAS FIRED FORCED AIR FURNACE MOUNTED JUST BELOW THE ROOF JOISTS IN THE MEZZANINE AREA. THERE IS NO COOLING SYSTEM IN THE OFFICE AREA. THE WAREHOUSE IS HEATED BY 12 UNIT HEATERS SUSPENDED JUST BELOW THE ROOF JOISTS. EACH UNIT HAS ITS OWN THERMOSTAT. THERE ARE NO AUTOMATIC SETBACK SYSTEMS.

ARTIFICIAL LIGHTING IS H.I.D. FIXTURES IN THE WAREHOUSE, AND FLUORESCENT FIXTURES IN THE OFFICE. THE NATURAL LIGHT PROVIDED BY THE TRANSLUCENT PLASTIC GLAZING IS USEFUL AT THE WEST SHIPPING AREA. THERE IS ONE ELECTRIC HOT WATER TANK.

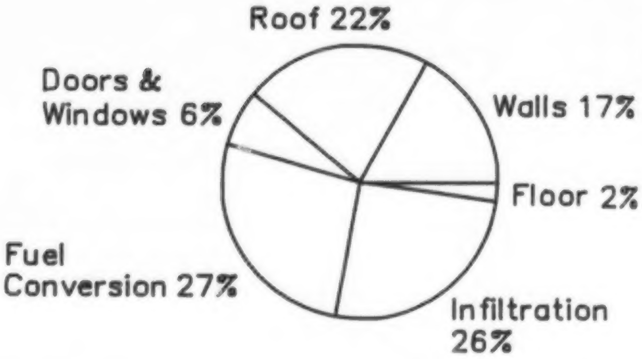
ENERGY : NATURAL GAS ONLY PROVIDES SPACE HEATING, WHILE LIGHTING, MOTORS, HOT WATER HEATING AND FORK LIFT VEHICLES ARE ELECTRIC. THE 1982 GAS CONSUMPTION WAS 6,095 GJ, $27,168, 1.15 GJ/$m^2$YEAR, 0.23 GJ/$m^3$ YEAR. THE 1982 ELECTRIC CONSUMPTION WAS 439 GJ, $5,022, 0.083 GJ/$m^2$ YEAR.

Building #35

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THOUGH THE OCCUPANTS LEASE THE BUILDING, THEY HAVE IMPLEMENTED SEVERAL ENERGY CONSERVATION MEASURES. THE H.I.D. LIGHTING AND THE TRAILER SEALS ARE BOTH RETROFITS.THE LIGHTING RETROFIT PLUS THE LOW AVERAGE LEVEL OF ILLUMINATION WOULD SEEM TO ACCOUNT FOR THIS RELATIVELY LOW ELECTRICAL ENERGY INDEX OF 0.083 GJ/m^2 YEAR.

THE SPACE HEATING ENERGY CONSUMPTION INDEX (1.15 GJ/m^2 YEAR) IS SOMEWHAT HIGHER THAN THAT FOR OTHER WAREHOUSE BUILDINGS. CALCULATIONS SUGGEST THAT AIR LEAKAGE IS THE MOST SIGNIFICANT SOURCE OF HEAT LOSS (36%), FOLLOWED BY THE ROOF (30%) AND THE UNINSULATED WALLS (24%).THE NATURAL VENTILATION RATE IS ESTIMATED TO BE 0.55 AIR CHANGES PER HOUR. THIS FIGURE IS BASED ON THE TOTAL ENERGY CONSUMPTION DURING 1982, AND WOULD BE DIFFERENT IF OUR ASSUMPTION OF THE ROOF INSULATION THICKNESS IS WRONG.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-36

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OWNER/OCCUPANT IN 1974. IT IS USED AS RENTAL WAREHOUSING. THE OWNER USES HALF OF THE OFFICE SPACE. THE REMAINING OFFICE SPACE IS LEASED. SOME 20% OF THE OFFICE AREA IS VACANT. AS A PUBLIC WAREHOUSE, THE FACILITY OPERATED FOR 12 HOURS A DAY ON WEEKDAYS.

A STUDY OF SHIPPING DOOR USE WAS DONE IN 1977. THE TRUCK DOORS WERE OPEN BETWEEN 4% AND 54% OF THE WORKING DAY. THE OVERALL AVERAGE TIME OPEN WAS 37% OF THE WORKING DAY. TIMES OF PEAK USE WHERE FROM 11.00 AM TO 12.00 NOON AND FROM 1.00 PM TO 2.00 PM.

STRUCTURE : THIS IS A LARGE ONE STOREY WAREHOUSE WITH A MEZZANINE LEVEL OVER THE TRUCK RECEIVING AREAS. THERE ARE TWO OFFICE FLOORS AT THE EAST END OF THE BUILDING. THE AREA OF THE MAIN FLOOR OF THE BUILDING IS 19,148 m^2, THE MEZZANINE AREA IS 1,965 m^2 AND THE TWO OFFICE FLOORS TOTAL 854 m^2. THE CLEAR HEIGHT IN THE WAREHOUSE IS 7.8 m.

THE STRUCTURAL BEAMS, COLUMNS, ROOF DECK, WALL PANELS AND MEZZANINE FLOOR DECK ARE PRECAST CONCRETE. THE BUILDING WAS ORIGINALLY DESIGNED TO HAVE A STEEL STRUCTURE , HOWEVER A STRIKE IN THE STEEL INDUSTRY RESULTED IN THE BUILDING BEING REDESIGNED.

THE ROOF DECK HAS AN UPWARD CAMBER THAT TENDS TO MOVE RAINWATER TOWARDS THE DRAINS. THE ROOF HAS A BUILT-UP MEMBRANE ON A 12 mm WOOD FIBER BOARD BASE IN THE WEST AREA, AND ON A 25 mm RIGID INSULATION BOARD BASE IN THE EAST AREA.

THE WALLS ARE UNINSULATED 200 mm HOLLOW CORE PRECAST CONCRETE PANELS. THE FOUNDATION WALL IS ALSO PRECAST CONCRETE. THE FLOOR SLAB EXTENDS OVER THE PRECAST FOUNDATION WALL PANELS TO TIE THEM TOGETHER. THERE ARE EIGHT OVERHEAD DOORS TO SERVICE A RAIL SIDING ON THE NORTH SIDE OF THE BUILDING. ON THE SOUTH SIDE OF THE BUILDING THERE IS ONE LARGE OVERHEAD DOOR TO ALLOW TRUCKS TO ENTER THE BUILDING. IT IS SELDOM USED. MOST OF THE SHIPPING AND RECEIVING IS DONE BY TRUCKS USING THE 15 LOADING DOCKS AT THE SOUTH SIDE OF THE BUILDING. HALF OF THESE 15 SHIPPING DOORS HAVE TRAILER SEALS. THE DOCK LEVELLERS ARE NOT SEALED.

THERE ARE TWELVE SKYLIGHTS IN THE WAREHOUSE ROOF. THEY ARE EQUIPPED WITH SPRING FRAMES AND FUSIBLE LINK CLOSERS TO PURGE SMOKE IN CASE OF FIRE.

SYSTEMS : THE WAREHOUSE AREA IS HEATED BY NATURAL GAS UNIT HEATERS SUSPENDED BELOW THE ROOF OR MEZZANINE. THERE ARE NO COOLING OR EXHAUST SYSTEMS ON THIS AREA.

THE OFFICE IS HEATED AND COOLED BY FORCED AIR UNITS MOUNTED ON THE ROOF. THE HEATING SECTIONS ARE GAS FIRED. THERE APPEARS TO BE PROVISION FOR A FRESH AIR INTAKE IN THE RETURN AIR PLENUM.

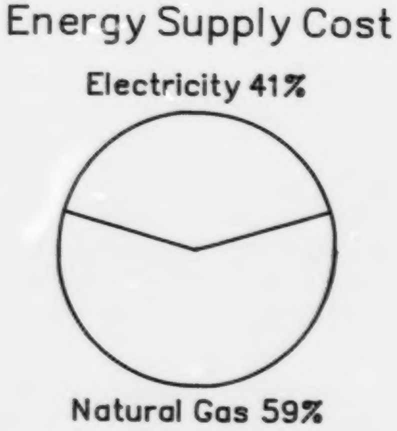
SOME OFFICE AREAS ALSO HAVE ELECTRIC BASE BOARD HEATERS TO SUPPLEMENT THE CENTRAL SYSTEM. THESE OFFICE HEATING SYSTEMS ARE SETBACK ON WEEKENDS.

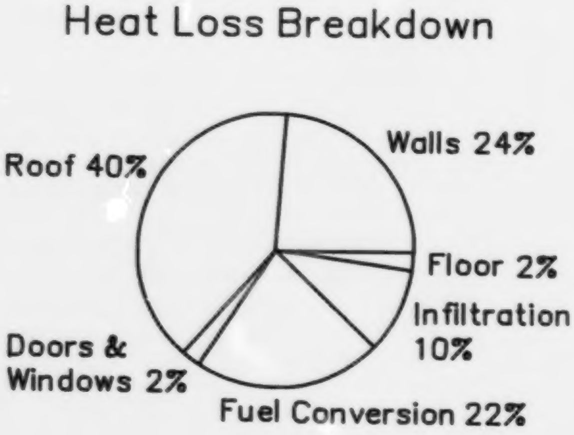
MERCURY VAPOUR FIXTURES SUPPLEMENT NATURAL LIGHTING IN THE WAREHOUSE. ARTIFICIAL LIGHTING IN THE OFFICES IS FLUORESCENT. THREE ELECTRIC TANKS SUPPLY ALL OF THE HOT WATER.

THERE ARE SIX PROPANE POWERED FORK LIFT TRUCKS AND ONE ELECTRIC FORK LIFT.

ENERGY : NATURAL GAS IS ONLY USED FOR SPACE HEATING. ELECTRICITY PROVIDES SOME SPACE HEAT IN THE OFFICE AREAS, BUT IS MOSTLY USED FOR LIGHTING AND EQUIPMENT. OVER THE 1981-82 HEATING SEASON NATURAL GAS CONSUMPTION WAS 11,110 GJ, $42,578, 0.58 GJ/m^2 YEAR, 0.075 GJ/m^3 YEAR. ELECTRICAL CONSUMPTION FOR THE SAME PERIOD WAS 2,887 GJ, $29,101, 0.15 GJ/m^2 YEAR.

Building #36





COMMENTS : BASED ON THE GJ/m^2 INDICES, BOTH SPACE HEATING AND ELECTRICAL CONSUMPTION ARE LOWER THAN THE AVERAGE OF WAREHOUSE BUILDINGS THAT WE HAVE EXAMINED. THE LOW SPACE HEATING REQUIREMENT WOULD APPEAR TO BE DUE TO THE LOW AIR LEAKAGE RATE OF 0.10 AIR CHANGES PER HOUR. THE WALLS AND ROOF ARE RELATIVELY AIR TIGHT, AND THE SHIPPING DOORS HAVE TRAILER SEALS. HOWEVER, EVEN THOUGH THE AIR CHANGE RATE IS QUITE LOW, BECAUSE OF THE LARGE SIZE OF THE BUILDING AIR LEAKAGE STILL ACCOUNTS FOR 13% OF THE ANNUAL HEAT LOSS. THE OTHER MAJOR CONTRIBUTORS ARE THE NOMINALLY INSULATED ROOF (53%) AND THE UNINSULATED WALLS (25%).

THE OCCUPANTS REPORT THAT THE BUILDING IS CONSISTENTLY COOL IN THE SUMMER. THIS IS NO DOUBT DUE TO THE THERMAL INERTIA OF THE CONCRETE IN THE WALLS AND PARTICULARLY THE ROOF, THE LOW AIR CHANGE RATE AND THE SIZE OF THE FACILITY, AND POSSIBLY THE PONDING OF RAIN WATER ON SOME SECTIONS OF THE ROOF.

THE LIGHT LEVELS IN THE WAREHOUSE ARE QUITE LOW (10f.c.) BUT APPEAR TO BE ADEQUATE. ILLUMINATION BELOW THE SKYLIGHTS WAS MARGINALLY BETTER BUT IT SHOULD BE NOTED THAT THE SKY WAS OVERCAST DURING OUR SURVEY.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-37

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY : THIS BUILDING WAS BUILT FOR THE CURRENT OWNER IN 1973 TO BE PUBLIC WAREHOUSING. AN OFFICE AREA IS ATTACHED TO THE WEST SIDE OF THE BUILDING. MOST OF THE OFFICE AREA IS EITHER UNOCCUPIED, OR USED FOR STORAGE PURPOSES. THE BUILDING IS USED 9.5 HOURS ON WEEKDAYS. THE SPACE IS RENTED TO MANY CLIENTS WHO STORE SMALL QUANTITIES OF DRY GOODS.

STRUCTURE : THIS IS A ONE STOREY BUILDING WITH A TOYAL FLOOR AREA OF 18,427 m^2, OF WHICH 1,476 m^2 IS OFFICE SPACE. THE ROOF DECK IS 8.1 m ABOVE THE FLOOR SLAB IN THE WAREHOUSE, AND 4.3 m ABOVE THE FLOOR SLAB IN THE OFFICES.

STRUCTURAL STEEL BEAMS AND COLUMNS SUPPORT THE STEEL JOISTS AND STEEL ROOF DECK. THE ROOF IS A BUILT UP MEMBRANE ON 38 mm THICK RIGID INSULATION. THE WAREHOUSE WALLS ARE TYPICALLY PRE-FINISHED METAL CLADDING OVER 38 mm THICK RIGID INSULATION WITH A STEEL INTERIOR LINER. HOWEVER, ONE END WALL IS LINED WITH CONCRETE BLOCK TO PROVIDE FIRE SEPARATION FROM AN ADJACENT BUILDING. THE OFFICE WALLS ARE STUCCO ON CONCRETE BLOCK WITH 38 mm THICK INSULATION AND DRYWALL ON THE INTERIOR.

THERE ARE TWO LARGE (24 m^2) SHIPPING DOORS IN THE NORTH WALL OF THE BUILDING, AND 9 SMALLER (9.4 m^2) SHIPPING DOORS LOCATED IN THE SOUTH WALL, 8 OF WHICH SERVE THE RAIL SIDING. THE LOADING AREAS ARE DESIGNED SO THAT THE TRUCKS DRIVE INTO THE BUILDING,AND THIS AREA IS NOT ISOLATED FROM THE REST OF THE BUILDING.

SIGNIFICANT NATURAL LIGHTING IS PROVIDED BY 474 m^2 OF STRIP WINDOWS AT THE TOP OF THE WAREHOUSE WALL, AND WINDOWS IN THE OFFICE AREA.

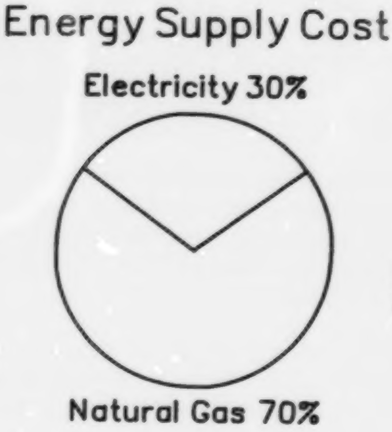
SYSTEMS : THE OFFICE IS HEATED AND COOLED BY A FORCED AIR SYSTEM WITH THE UNIT MOUNTED ON THE ROOF. HEATING IS INDIRECT FIRED NATURAL GAS, AND COOLING IS ELECTRIC. A COMPUTER ROOM WITHIN THE OFFICE AREA HAS ITS OWN COOLING SYSTEM. THE WAREHOUSE IS HEATED BY SIX INDIRECT FIRED NATURAL GAS FORCED AIR SYSTEMS, TWO OF WHICH HAVE FRESH AIR INTAKES. THREE EXHAUST FANS IN THE SHIPPING AREA REMOVE TRUCK EXHAUST FUMES. THE EXHAUST FANS ARE SWITCHED ON BY THE OCCUPANTS. AN AUTOMATIC SET BACK CONTROL TO LOWER THE TEMPERATURE AT NIGHT AND ON WEEKENDS WAS ADDED IN DECEMBER OF 1982.

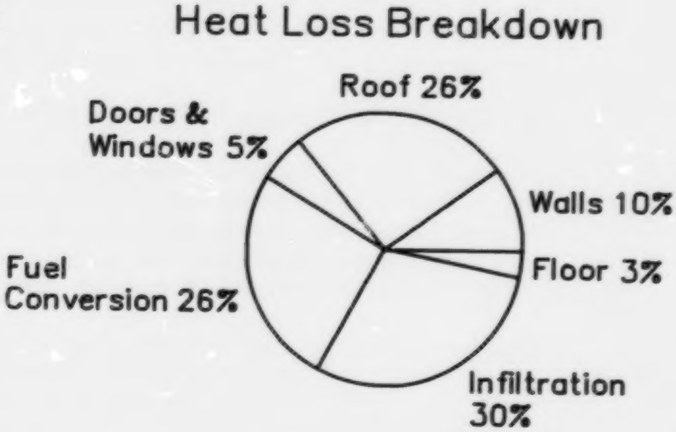
ARTIFICIAL LIGHTING IS TYPICALLY FLUORESCENT IN BOTH THE WAREHOUSE AND OFFICE AREAS, WHILE THE SHIPPING AREAS HAVE HIGH PRESSURE SODIUM FIXTURES.

DOMESTIC HOT WATER IS PROVIDED BY ELECTRICALLY HEATED TANKS. THERE ARE EIGHT PROPANE FORKLIFTS AND ONE ELECTRIC FORKLIFT.

ENERGY : NATURAL GAS IS ONLY USED FOR SPACE HEATING. IN 1982 GAS CONSUMPTION WAS 13,458 GJ, \$58,171, 0.73 GJ.m^2 YEAR, 0.087 GJ/m^3 YEAR. ELECTRICITY IS USED FOR LIGHTING, COOLING, HOT WATER HEATING AND THE OPERATION OF EQUIPMENT. 1982 CONSUMPTION WAS 2,484 GJ, \$25,324, 0.13 GJ/m^2 YEAR.

Building #37





COMMENTS : THE SPACE HEATING ENERGY CONSUMPTION IS ABOUT AVERAGE FOR THIS TYPE AND SIZE OF BUILDING. THE MAJOR CONTRIBUTOR IS THE NATURAL AIR LEAKAGE RATE OF 0.32 AIR CHANGES PER HOUR (43%). THIS IS PARTIALLY DUE TO THE DESIGN OF THE SHIPPING AREA, AND THE FACT THAT THE DOORS ARE LOCATED IN THE NORTHWEST FACE OF THE BUILDING. FOR MUCH OF THE WINTER THIS IS A WINDWARD FACE. THE BULK OF THE REMAINING HEAT LOAD IS ASSOCIATED WITH THE ROOF (35%) AND THE WALLS (13%).

THE ELECTRICAL CONSUMPTION IS SOMEWHAT ABOVE AVERAGE FOR WAREHOUSE BUILDINGS. THIS MAY BE DUE TO OFFICE AREA CONSUMPTION FOR LIGHTING, COMPUTER OPERATION, AND BOTH GENERAL OFFICE AND COMPUTER ROOM AIR CONDITIONING.

BUILDING ENGINEERING GROUP - BUILDINGS ENERGY TECHNOLOGY TRANSFER - BUILDING PERFORMANCE SURVEY

FILE NUMBER : 20601-38

BUILDING TYPE : WAREHOUSE

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY : THE BUILDING WAS BUILT FOR THE CURRENT OWNER/OCCUPANTS IN 1968. A MAJOR ADDITION WAS ADDED IN 1970. THE BUILDING IS ADJACENT TO A RAIL SIDING. IT IS RENTED TO ONE LARGE COMPANY FOR STORAGE OF DRY GOODS. IT IS USED FOR 9.5 HOURS ON WEEKDAYS. THERE IS NO OFFICE SPACE IN THIS BUILDING.

STRUCTURE : THIS IS A ONE STORY BUILDING WITH A TOTAL FLOOR AREA OF 18,305 m^2. THE ROOF DECK IS 8.1 m ABOVE THE FLOOR SLAB. THE STRUCTURAL MEMBERS ARE STEEL BEAMS AND COLUMNS SUPPORTING STEEL JOISTS AND STEEL ROOF DECK. THE ROOF IS A BUILT-UP MEMBRANE ON 38 mm THICK RIGID INSULATION. THE WALLS ARE PRE-FINISHED STEEL CLADDING OVER 38 mm THICK RIGID INSULATION WITH A STEEL INTERIOR LINER.

THERE ARE 9 OVERHEAD DOORS IN THE NORTH WALL, 8 SERVE THE RAIL SIDING. IN ADDITION, 9 SHIPPING DOORS SERVING TRUCK TRAFFIC ARE LOCATED ON THE SOUTH SIDE OF THE BUILDING. THREE 4.9 m x 4.9 m DOORS ALLOW TRUCKS TO ENTER THE BUILDING, AND SIX ARE 2.4 m x 3.0 m AT 1.2 m ABOVE GRADE TO SERVE THE LOADING DOCKS. HOWEVER THE MAIN LOADING DOCK AREA IS DESIGNED SO THAT THE TRUCKS AND THEIR TRAILERS ARE BROUGHT INTO THE BUILDING. THEREFORE, TWO OF THE LARGE OVERHEAD DOORS ARE OFTEN OPEN. WHEN BOTH THE RAIL AND TRUCK DOORS ARE OPEN THE BUILDING CAN BE UNCOMFORTABLY COLD.

THERE IS CONTINUOUS GLAZING AROUND THE BUILDING AT THE TOP OF THE WALL. THESE WINDOWS PROVIDE SIGNIFICANT NATURAL LIGHTING. SINCE SOME WINDOWS ARE OPENABLE,THEY ARE USED FOR NATURAL VENTILATION.

SYSTEMS : THE WAREHOUSE AND SHIPPING AREAS ARE HEATED BY SIX LARGE FORCED AIR SYSTEMS SUSPENDED BELOW THE STEEL JOISTS, TWO OF THESE UNITS HAVE FRESH AIR INTAKES, NONE HAVE ANY COOLING EQUIPMENT.

THERE ARE THREE EXHAUST FANS, EACH 0.5 m DIA., IN THE LOADING AREA TO REMOVE THE TRUCK ENGINE FUMES. THESE EXHAUST FANS ARE CONTROLLED BY MEANS OF A CO$_2$ MONITOR. THE HEATING SYSTEM IS NOT AUTOMATICALLY SETBACK TO A LOWER TEMPERATURE ON NIGHTS AND ON WEEKENDS, HOWEVER, SUCH A SYSTEM IS CURRENTLY UNDER CONSIDERATION.

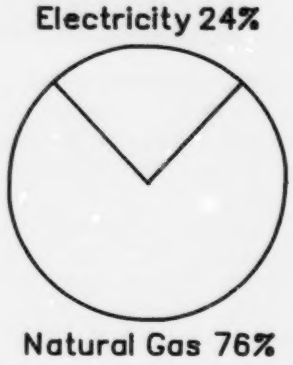
ARTIFICIAL LIGHTING IS TYPICALLY FLUORESCENT, HOWEVER, THE TRUCK LOADING AREA HAS HIGH PRESSURE SODIUM FIXTURES. MUCH OF THE LIGHT IS PROVIDED BY THE PERIMETER WINDOWS NEAR THE ROOF. DOMESTIC HOT WATER IS PROVIDED BY TWO ELECTRICALLY HEATED TANKS.

THERE ARE SIX PROPANE FORK LIFT TRUCKS, AND NO ELECTRIC VEHICLES.

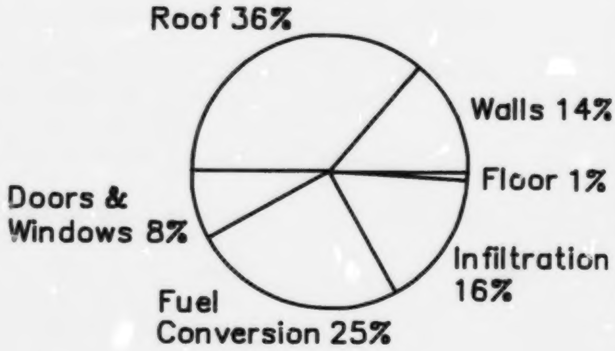
ENERGY : NATURAL GAS IS ONLY USED FOR SPACE HEATING. THE 1982 GAS CONSUMPTION IS ESTIMATED TO BE 7,388 GJ, $35,252, 0.40 GJ/m^2 YEAR, 0.048 GJ/m^3 YEAR. ELECTRICITY IS USED FOR LIGHTING, HOT WATER HEATING AND MISCELLANEOUS MOTOR OPERATION. 1982 ELECTRICITY CONSUMPTION WAS 1,567 GJ, $11,208, 0.08 GJ/m^2 YEAR.

Building #38

Energy Supply Cost



Heat Loss Breakdown



COMMENTS : THE SPACE HEAT ENERGY CONSUMPTION INDICES LISTED ABOVE ARE ESTIMATES ONLY SINCE THIS BUILDING WAS UNOCCUPIED FOR PART OF THE HEATING SEASON, HENCE THE SHIPPING DOORS REMAINED CLOSED. THE FUEL CONSUMPTION FROM DECEMBER 1982 TO JUNE 1983 WAS MATCHED WITH WEATHER DATA FROM THE SAME PERIOD, AND A 'NORMAL' NATURAL VENTILATION RATE WAS CALCULATED FOR THE BUILDING DURING ITS TYPICAL USE. THAT NATURAL VENTILATION RATE OF 0.12 ACPH WAS THEN EMPLOYED IN A COMPUTER RUN USING 1982 WEATHER DATA, AND THE OUTPUT IS THE BASIS FOR OUR COMPARISONS AND INDICIES.

THE SPACE HEATING ENERGY CONSUMPTION IS SOMEWHAT LOWER THAN AVERAGE FOR THIS TYPE OF BUILDING. THIS MAY BE DUE TO THE LOW COMBINED MECHANICAL AND NATURAL VENTILATION RATE WHICH IS ESTIMATED TO BE 0.12 AIR CHANGES PER HOUR. INFILTRATION ACCOUNTS FOR 22% OF THE ANNUAL HEAT LOSS. THE ROOF (48%) IS THE GREATEST CONTRIBUTOR TO THE HEATING BILL, AND THE WALLS (19%) ACCOUNT FOR THE BULK OF THE REMAINDER.

THE RELATIVELY LOW AIR CHANGE RATE IS MOST LIKELY ASSOCIATED WITH TWO FACTORS. THE TRUCK SHIPPING AREA IS ON THE SOUTH SIDE OF THIS BUILDING, THEREFORE IT IS SHELTERED FROM THE PREVAILING WINTER WINDS. THERE ARE 9 OVERHEAD DOORS FOR SHIPPING AND RECEIVING FROM A RAIL SIDING AT THE NORTH SIDE OF THIS BUILDING. THEY ARE USED LESS FREQUENTLY THAN THE TRUCK DOORS, HOWEVER, SINCE THERE ARE NO AIRSEAL DEVICES TO REDUCE AIR INFILTRATION, WHEN THE DOORS ARE USED, A HIGH AIR LEAKAGE RATE WOULD BE EXPECTED. THIS DOES NOT OCCUR SINCE THE DOORS ARE ONLY 14 m SOUTH OF AN ADJACENT BUILDING. THIS OTHER 10 m WALL PROVIDES A WINDBREAK AGAINST THE COLDEST WINTER WINDS. ALSO, WHENEVER THE DOOR IS OPEN, THERE IS A BOXCAR IN FRONT OF THE OPENING, ACTING AS A BARRIER TO AIRFLOW.

OCCUPANCY MAY ALSO HAVE AN EFFECT ON THE NATURAL VENTILATION RATE. THIS BUILDING IS LEASED BY A MAJOR APPLIANCE MANUFACTURER. THE LOADS SHIPPED AND RECEIVED WOULD TEND TO BE RELATIVELY LARGE, SUGGESTING THAT THE DOORS WOULD BE OPENED LESS FREQUENTLY THAN IF THE BUILDING WAS RENTED BY MANY SMALLER FIRMS, SHIPPING SMALLER LOADS.

FILE NUMBER : 20601-39

BUILDING TYPE : LIGHT INDUSTRIAL

BUILDING NAME : CONFIDENTIAL

BUILDING ADDRESS : CONFIDENTIAL

LOCATION : TORONTO, ONTARIO

OCCUPANCY : THIS IS A LARGE COMPLEX THAT INCLUDES OFFICE AREAS, SHOWROOMS, A LARGE CAFETERIA, PRODUCTION SPACE, STORAGE AND SHIPPING/RECEIVING AREAS. IT WAS BUILT IN STAGES FOR THE OCCUPANT/OWNER, A MAJOR OFFICE FURNITURE MANUFACTURER. THE FACILITY IS OPERATED FOR SIXTEEN HOURS ON WEEKDAYS. THE OFFICE AREA IS USED EIGHT HOURS ON WEEKDAYS.

STRUCTURE : MOST OF THE COMPLEX IS A ONE STOREY STEEL BEAM AND COLUMN STRUCTURE WITH A CLEAR HEIGHT OF 6.1 m. THE MOST RECENT ADDITION IS A TWO STOREY PRECAST CONCRETE STRUCTURE. THE TOTAL HEIGHT OF THE TWO FLOORS IS 12.6 m. THE BEAMS, COLUMNS, FLOORS, ROOF DECK AND WALL PANELS ARE ALL PRECAST CONCRETE IN THIS PART OF THE BUILDING. THE TOTAL USEABLE FLOOR AREA IS APPROXIMATELY 65,000 m^2, INCLUDING MEZZANINES AND THE SECOND FLOOR IN THE PRODUCTION AREA.

THE ROOF IN THE ORIGINAL BUILDING IS A BUILT-UP MEMBRANE ON RIGID INSULATION. THE ROOF IN THE PRECAST CONCRETE ADDITION IS A PROTECTED MEMBRANE SYSTEM WITH THE INSULATION PLACED ON TOP OF THE BUILT-UP ROOF MEMBRANE. THIS INSULATION IS COVERED BY A WOVEN PLASTIC FABRIC AND CRUSHED STONE. THE ONLY INSULATED WALLS ARE THE PRECAST PANELS, WHICH HAVE RIGID INSULATION AT THEIR CENTER.

THE SHIPPING/RECEIVING AREA IS DESIGNED SO THAT THE TRUCKS ENTER THE BUILDING. THE TWO LARGE DOORS ARE THEREFORE OFTEN OPEN. SHIPPING DOORS AT OTHER LOCATIONS IN THE BUILDING HAVE TRAILER SEALS.

SYSTEMS : THE VARIETY OF HEATING, COOLING, EXHAUST, MAKE-UP AIR AND PROCESS EQUIPMENT MAKE THIS BUILDING TOO COMPLICATED FOR ANALYSIS WITH BEGEN3, OUR ANALYSIS PROGRAM. TO PERFORM A MEANINGFUL AND AUTHORITATIVE AUDIT WOULD REQUIRE MORE TIME AND STUDY THAN WE CAN PROVIDE UNDER OUR CURRENT MANDATE. HENCE WE HAVE NOT DOCUMENTED DETAILS OF ALL SERVICE AND PROCESS EQUIPMENT. IN GENERAL, ALL SPACE HEATING IS GAS FIRED.

IN THE ORIGINAL BUILDING, ARTIFICIAL LIGHTING WAS FLUORESCENT BUT THIS WAS CHANGED TO LOW PRESSURE SODIUM FIXTURES AS AN ENERGY CONSERVATION MEASURE. IN THE PRECAST ADDITION, HIGH PRESSURE SODIUM LIGHTS WERE INSTALLED TO AVOID THE YELLOW COLOUR OF THE LOW PRESSURE SODIUM BULBS.

ENERGY : EVEN THOUGH ALL SPACE HEATING IS PROVIDED BY NATURAL GAS FIRED UNITS, AN EVALUATION OF THE SPACE HEATING ENERGY CONSUMPTION IS NOT POSSIBLE SINCE A LARGE AND UNRECORDED QUANTITY OF NATURAL GAS IS USED FOR PROCESS PAINT DRYING. ALSO, THE ELECTRICAL CONSUMPTION SIGNIFICANTLY AFFECTS THE SPACE

HEAT ENERGY CONSUMPTION AND IT IS NOT POSSIBLE TO DETERMINE THE PROPORTION OF HOW MUCH OF THAT ELECTRICAL ENERGY THAT IS USED IN REDUCING THE SPACE HEATING LOAD, THIS WOULD REQUIRE MORE DETAILED FUEL RECORDS AND USE OF AN HOUR BY HOUR COMPUTER SIMULATION OF THE HEAT GAINS AND LOSSES.

THE 1982-83 GAS CONSUMPTION WAS 97,384 GJ, \$432,000, 1.5 GJ/m^2 YEAR, 0.25 GJ/m^3 YEAR. THE 1982-83 ELECTRICAL CONSUMPTION WAS 27,610 GJ, \$285,000, 0.42 GJ/m^2 YEAR.

COMMENTS : THE QUALITY OF DESIGN AND CONSTRUCTION ARE GENERALLY ABOVE AVERAGE. THE ENERGY CONSUMPTION INDICES FOR THIS BUILDING ARE BOTH MUCH HIGHER THAN THE AVERAGE, BUT IT IS INAPPROPRIATE TO COMPARE THIS FACILITY WITH OTHER INDUSTRIAL BUILDINGS DUE TO THE HIGH DEGREE OF MECHANIZATION AND PARTICULARLY THE PAINT DRYING EQUIPMENT.

ELECTRICAL CONSUMPTION COSTS ARE LESS THAN THAT FOR NATURAL GAS FOR PROCESS DRYING AND SPACE HEATING. ENERGY CONSERVATION MEASURES APPEAR TO HAVE BEEN FOCUSSED ON LIGHTING AND EQUIPMENT OPERATION, POSSIBLY BECAUSE PROCESS HEAT RECOVERY IS TECHNICALLY DIFFICULT TO IMPLEMENT.

THE MAJOR GAS CONSUMING PROCESS EQUIPMENT IS A LARGE PAINT DRYING LINE. CURRENTLY NO HEAT IS RECOVERED FROM THE EXHAUST FROM THIS UNIT. THE COMPANY IS CONSIDERING HEAT RECOVERY SCHEMES AT THIS TIME.

APPENDIX B

SAMPLE OUTPUT OF BEGEN 3 ENERGY ANALYSIS PROGRAM AND dbBEG DATABASE

BEGEN3

A PROGRAM TO PREDICT SPACE HEAT REQUIREMENTS IN HOUSES AND OTHER BUILDINGS

FILE NO. 20601-1

THIS PRINTOUT WAS MADE ON JANUARY 25 1985

CALCULATIONS ARE BASED ON DATA FOR WATERLOO 81-82

```
                             BUILDING PARAMETERS
                             -------------------
                           RATE OF       ELEMENT                ANNUAL
ELEMENT         AREA       RSI VALUE     HT LOSS         %      HT LOSS
                 M2        M2-DEGC/W     W/DEGC      HT LOSS    GJ
*****************************************************************************

ROOF            2838          .88
    TOTAL       2838          .88          3225        26.6        641.6
-------------------------------------------------------------------------
MAIN WALLS      957           .35
    TOTAL       957           .35          2734.3      22.5        544
-------------------------------------------------------------------------
BASEMENT AB.GD  0             0
    TOTAL       0             0            0           0           0
-------------------------------------------------------------------------
DOORS           120           .2
    TOTAL       120           .2           600         4.9         119.4
-------------------------------------------------------------------------
SOUTH WINDOWS   6.9           .2
    TOTAL       6.9           .2           34.5        .3          6.9
-------------------------------------------------------------------------
NORTH WINDOWS   8.4           .2
    TOTAL       8.4           .2           42          .3          8.4
-------------------------------------------------------------------------
EAST WINDOWS    10.2          .2
    TOTAL       10.2          .2           51          .4          10.1
-------------------------------------------------------------------------
WEST WINDOWS    6.5           .2
    TOTAL       6.5           .2           32.5        .3          6.5
*****************************************************************************
BASEMENT 600MM  0             0
    TOTAL       0             0            0           0           0
-------------------------------------------------------------------------
BASE. TO FLOOR  0             0
    TOTAL       0             0            0           0           0
-------------------------------------------------------------------------
FLOOR PERIMETER 218           .2
    TOTAL       218           .2           158.2       .7          15.7
-------------------------------------------------------------------------
FLOOR CENTRE    2620          .2
    TOTAL       2620          .2           147.3       .6          14.6
=========================================================================
SUB-GRADE
    TOTAL       2838                       305.5       1.26        30.4
*****************************************************************************
              RATE (/HR)     VOLUME (M3)
AIR CHANGE      1.14 /HR      13912          5263.3    43.4        1047.1

*****************************************************************************
```

```
                              BUILDING PARAMETERS
                              -------------------

GENERAL CONSIDERATIONS

TEMPERATURES (DEG C) MAIN FLOOR                                  =  13.4
                        BASEMENT                                 =  13.4

INTERNAL GAIN CONSIDERATIONS

SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D)                           =  10
DAILY BASE ELECTRIC CONSUMPTION (KWH/D)                          =  475.5
DAILY HOT WATER ENERGY CONSUMPTION (KWH/D)                       =  107
DAILY USEFUL INTERNAL GAINS (KWH/D)                              =  496.46

SOLAR CONSIDERATIONS

SOLAR CONSIDERATIONS

SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT                   =  1.2  M
                       : AVERAGE OVERHANG WIDTH                  =  .1   M
                       : AVERAGE HEIGHT ABOVE WINDOW             =  .1   M
SHADING COEFFICIENT  S=  1    E=  1
                     N=  1    W=  1
DAILY TEMPERATURE SWING (DEG C)                                  =  2.75

INFILTRATION CONSIDERATIONS

NATURAL INFILTRATION RATE (AC/HR)                                =  1.137695
FORCED VENTILATION RATE (AC/HR)                                  =  0


                  CALCULATED MONTHLY ENERGY CONSUMPTION
                  -------------------------------------

MONTH         THERMAL LOAD  SOLAR GAIN   AUX HEAT REQ   TOT CONS
                  KWH/D        KWH/D        KWH/D         KWH/D
****************************************************************************
 JAN           5237.7       36.25        5201.5        5784
 FEB           4627.5       50.03        4577.4        5159.9
 MAR           3062.2       58.33        3003.9        3586.4
 APR           681.4        66.79        614.6         1197.1
 MAY           0            0            0             582.5
 JUN           0            0            0             582.5
 JUL           0            0            0             582.5
 AUG           0            0            0             582.5
 SEP           0            0            0             582.5
 OCT           304.2        42.52        261.6         844.1
 NOV           1259.1       26.12        1233          1815.5
 DEC           3576.1       26.51        3549.6        4132.1
****************************************************************************
```

```
                            ENERGY CONSUMPTION SUMMARY
                            --------------------------

                                              KWHRS                  GJ
                                           ---------------------------------------
GROSS ANNUAL HEAT LOSS                       670620               2414.2
ANNUAL INTERNAL GAINS                        105250               378.9
ANNUAL SOLAR GAIN =                          9260                 33.3
NET ANNUAL HEAT LOSS                         556110               2002
TOTAL ANNUAL FUEL ENERGY REQUIRED            794440               2860

ANNUAL SOLAR FRACTION =   .02



                            ANNUAL PREDICTED FUEL COSTS
                            ---------------------------
                        FUEL COSTS ARE FOR WATERLOO 81-82

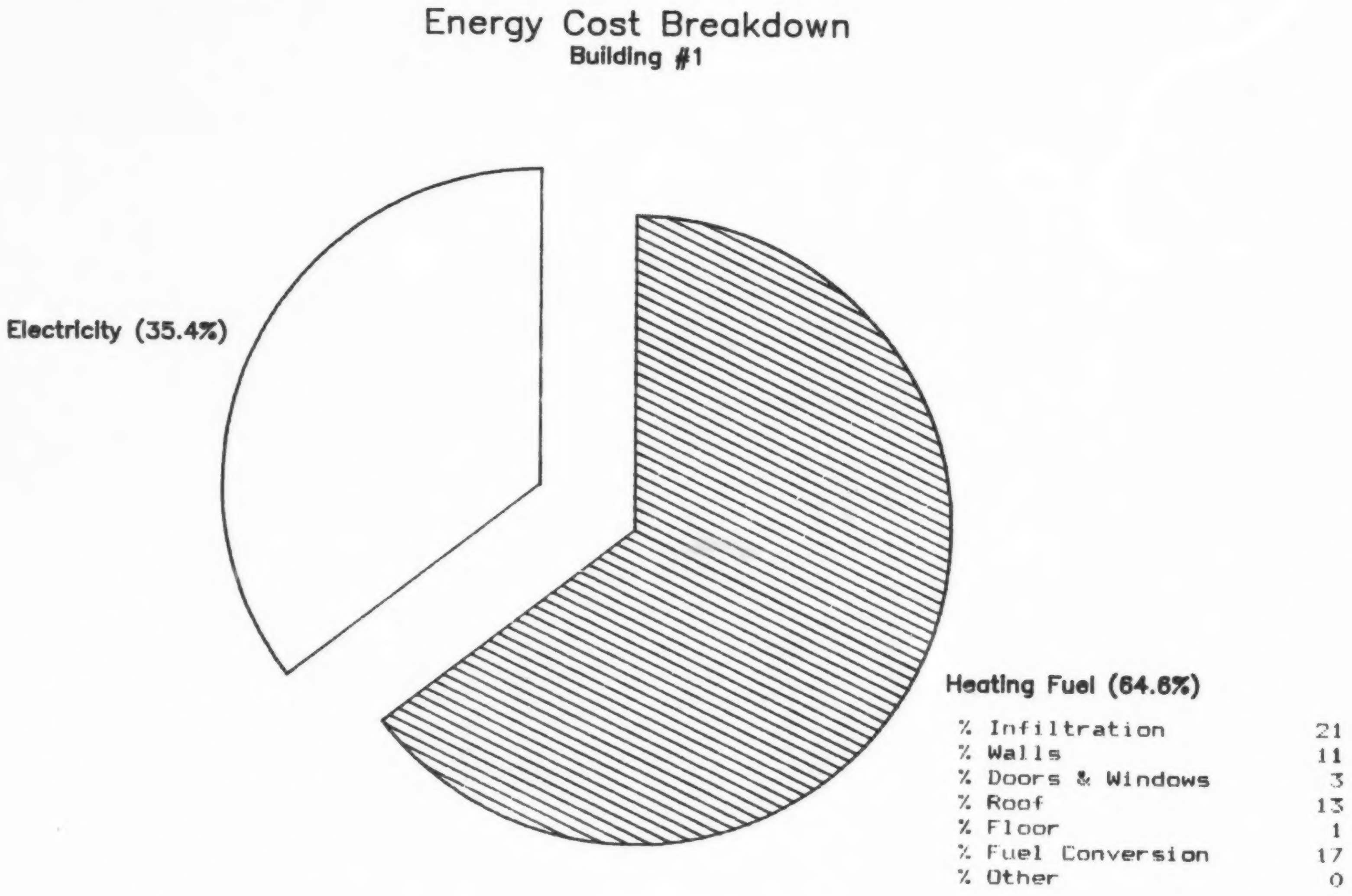
ENERGY           COST              SPACE            HOT           EQUIPMENT
SOURCE         PER UNIT       HEATING ($/YR) WATER ($/YR)         ($/YR)
*******************************************************************************
ELECTRICITY     3.57  C/KWH     $19840.00       $1390.00        $6190.00
                                EFF.= 100%     EFF.=100%        EFF.=100%

NATURAL GAS     14.08 C/M3      $10810.00       $970.00
                                EFF.=  70 %    EFF.= 55%           ---

OIL             26      C/L     $19070.00      $1700.00
                                EFF.=  70 %    EFF.= 55%           ---

PROPANE         15.72  C/L      $17560.00      $1570.00
                                EFF.=  70 %    EFF.= 55%           ---

WOOD            24.79 $/M3      $19370.00      $1700.00
                                EFF.= 50%      EFF.= 40%           ---
*******************************************************************************
```


Energy Cost Breakdown
Building #1
Electricity (35.4%)
Heating Fuel (64.6%)
% Infiltration 21
% Walls 11
% Doors & Windows 3
% Roof 13
% Floor 1
% Fuel Conversion 17
% Other 0

```
                          Building #       1

Natural Gas Index : (GJ/m^2)             1.01

Electricity Index : (GJ/m^2)             0.22
                  : (kWh/m^2)           61.17

Natural Gas End-use % Breakdown
          (based on GJ)

         % Infiltration                  32.0
         % Walls                         16.6
         % Doors & Windows                4.6
         % Roof                          19.6
         % Floor                          0.9
         % Fuel Conversion               26.2
         % Other                          *
                  TOTAL %                 100

Electricity End-use % Breakdown
          (based on GJ)

         % Int. Lighting                  *
         % Ext. Lighting                  *
         % Air-Conditioning               *
         % Other - internal               *
                 - external               *
                  TOTAL %                 100

* Cannot be determined from
  data gathered
```

```
 INITIAL DETAILS
  1  SURVEY DATE: 821012
  2  BUILDING TYPE:  WD
  3  LATITUDE: 43.26
  4  LONGITUDE:  80.30
  5  PROVINCE: ONT
  6  THE OCCUPANT OWNS THE BUILDING
  7  THE BUILDING WAS BUILT IN 1968
  8  THE INTERNAL BUILDING AREA IS     2838 sq. m.
  9  THE INTERNAL BUILDING VOLUME IS    13912 cu. m.

  OWNERSHIP, OCCUPANCY AND TENANCY DETAILS:
 HALF OF THE BUILDING IS RARELY USED. IT IS STORAGE SPACE FOR FILES
 FOR THE OWNER.  THE SHIPPING DOOORS IN THE MAINTENANCE AREA ARE OFTEN
 OPEN.

  BUILDING USE -- PAST AND PRESENT:
 THE BUILDING WAS DISMANTLED, THEN REBUILDT ON THE CURRENT SIGHT IN 1968.
 SOME SPACE IS USED FOR A SMALL RADIO STATION.


  ORIENTATION OF BUILDING (in degrees w.r.t. NORTH):  0
  PREVAILING WIND DIRECTION:  315

             FLOOR SYSTEM      # 1
 1. TYPE:  R/C SLAB ON GRADE
 2. FINISH:  MACHINE TROWELLED
 3. DATUM POINT:  TOP OF FLOOR SLAB
 4. FLOOR THICKNESS:     150mm
 5. LOW RIGHT CORNER: (    45725.   60965)
 6. UPPER LEFT CORNER:(       0 ,       0 )
 VAPOUR BARRIER:
 MATERIAL: POLYETHYLENE
 LOCATION: BELOW FLOOR
 THIS FLOOR SYSTEM IS NOT INSULATED
 PERIMETER JOINT
 1. FILLER MATERIAL: WOOD FIBER
 2. WIDTH: 12 mm
 CRACK CONTROL JOINT PATTERN
 1. DIMENSION - X :
 2. DIMENSION - Y :
 3. CONDITION: EFFECTIVE

             FLOOR SYSTEM      # 2
 1. TYPE:  R/C SLAB ON GRADE
 2. FINISH:  MACHINE TROWELLED
 3. HEIGHT ABOVE DATUM: -150 mm
 4. FLOOR THICKNESS:     100mm
 5. LOW RIGHT CORNER: (    27074.   68216)
 6. UPPER LEFT CORNER:(    19374,   61715)
 THIS FLOOR SYSTEM IS NOT INSULATED
 PERIMETER JOINT
 1. FILLER MATERIAL: NONE
```

```
CRACK CONTROL JOINT PATTERN
1. DIMENSION - X :
2. DIMENSION - Y :
3. CONDITION: EFFECTIVE

           FOUNDATION WALL   # 1
1. TYPE:  CAST IN PLACE CONCRETE
2. LENGTH BELOW GROUND:   1400mm
3. LENGTH ABOVE GROUND:  200  mm
4. THICKNESS:     300mm
5. EXTERNAL FINISH: NONE
6. LOWER RIGHT CORNER: (       0 ,-  1200)
7. UPPER LEFT CORNER: (  226480.      0)

FOUNDATION FOOTING
1. FOOTING TYPE: CAST IN PLACE CONCRETE
2. THICKNESS:   200mm
3. WIDTH:   500mm
FOUNDATION WALL IS NOT INSULATED

 1st Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (0        ,0      )
2. UPPER LEFT CORNER: (45725    ,4920  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  0
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK

 2nd Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (45725    ,0      )
2. UPPER LEFT CORNER: (106690   ,4920  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  90
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK

 3rd Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (106690   ,0      )
2. UPPER LEFT CORNER: (125341   ,4920  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  180
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK
 4th Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (125341  .0     )
2. UPPER LEFT CORNER: (131841  .3905  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  90
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK

 5th Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (125341  .3905  )
2. UPPER LEFT CORNER: (133041  .4920  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  180
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK

 6th Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (131841  .0     )
2. UPPER LEFT CORNER: (139541  .3905  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  180
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK

 7th Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (140644  .0     )
2. UPPER LEFT CORNER: (146141  .3905  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  270
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK

 8th Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (146141  .0     )
2. UPPER LEFT CORNER: (165515  .4920  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  180
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
```

```
      MATERIAL: CONCRETE BLOCK

 9th Wall
    BUILDING WALLS
1. LOWER RIGHT CORNER: (165515  ,0      )
2. UPPER LEFT CORNER: (226480  ,4920  )
3. ORIENTATION OF WALL (in degrees w.r.t. NORTH):  270
4. RSI VALUE: .45

WALL ELEMENTS
 1st  STRUCTURE:  200  mm
      MATERIAL: CONCRETE BLOCK

         WINDOWS    SET # 1
1. WINDOW TYPE: INDUSTRIAL SASH
2. NUMBER OF WINDOWS: 3
3. LOWER RIGHT CORNER:(3687     .2379  )
4. UPPER LEFT CORNER: (5680     .3687  )
5. WINDOW SEPARATION :17792 mm
WINDOW GLAZING
1. GLAZING MATERIAL: GLASS
2. NUMBER OF GLAZINGS: 1
WINDOW FRAME
1. FRAME MATERIAL: ALUMINUM
2. THERMAL BREAK:  NONE
3. WEATHERSTRIP: FOAM PLASTIC
OVERHANG: Dim 'H': 0    mm
          Dim 'L': 0    mm
 FINS: Dim 'C': 0    mm
       Dim 'D': 0    mm
       Dim 'E': 0    mm

         WINDOWS    SET # 2
1. WINDOW TYPE: INDUSTRIAL SASH
2. NUMBER OF WINDOWS: 2
3. LOWER RIGHT CORNER:(78824   .2379  )
4. UPPER LEFT CORNER: (80857   ,3687  )
5. WINDOW SEPARATION :15344 mm
WINDOW GLAZING
1. GLAZING MATERIAL: GLASS
2. NUMBER OF GLAZINGS: 1
WINDOW FRAME
1. FRAME MATERIAL: ALUMINUM
2. THERMAL BREAK:  NONE
3. WEATHERSTRIP: FOAM PLASTIC
OVERHANG: Dim 'H': 0    mm
          Dim 'L': 0    mm
 FINS: Dim 'C': 0    mm
       Dim 'D': 0    mm
       Dim 'E': 0    mm

         WINDOWS    SET # 3
1. WINDOW TYPE: INDUSTRIAL SASH
```

```
2. NUMBER OF WINDOWS: 2
3. LOWER RIGHT CORNER:(119601  ,2379   )
4. UPPER LEFT CORNER: (121634  ,3687   )
5. WINDOW SEPARATION :39113 mm
WINDOW GLAZING
1. GLAZING MATERIAL: GLASS
2. NUMBER OF GLAZINGS: 1
WINDOW FRAME
1. FRAME MATERIAL: ALUMINUM
2. THERMAL BREAK:  NONE
3. WEATHERSTRIP: FOAM PLASTIC
OVERHANG: Dim 'H': 0    mm
          Dim 'L': 0    mm
 FINS: Dim 'C': 0    mm
       Dim 'D': 0    mm
       Dim 'E': 0    mm

         WINDOWS    SET # 4
1. WINDOW TYPE: INDUSTRIAL SASH
2. NUMBER OF WINDOWS: 2
3. LOWER RIGHT CORNER:(159158  ,1066   )
4. UPPER LEFT CORNER: (161191  .2266   )
5. WINDOW SEPARATION :10740 mm
WINDOW GLAZING
1. GLAZING MATERIAL: GLASS
2. NUMBER OF GLAZINGS: 1
WINDOW FRAME
1. FRAME MATERIAL: ALUMINUM
2. THERMAL BREAK:  NONE
3. WEATHERSTRIP: FOAM PLASTIC
OVERHANG: Dim 'H': 0    mm
          Dim 'L': 0    mm
 FINS: Dim 'C': 0    mm
       Dim 'D': 0    mm
       Dim 'E': 0    mm

         WINDOWS    SET # 5
1. WINDOW TYPE: FIXED
2. NUMBER OF WINDOWS: 1
3. LOWER RIGHT CORNER:(174940  ,0      )
4. UPPER LEFT CORNER: (175956  ,2288   )
WINDOW GLAZING
1. GLAZING MATERIAL: GLASS
2. NUMBER OF GLAZINGS: 2
3. GLAZING SEPARATION :12 mm
WINDOW FRAME
1. FRAME MATERIAL: ALUMINUM
2. THERMAL BREAK:  NONE
3. WEATHERSTRIP: GASKET
OVERHANG: Dim 'H': 0    mm
          Dim 'L': 0    mm
 FINS: Dim 'C': 0    mm
       Dim 'D': 0    mm
```

```
      Dim 'E': 0    mm

        WINDOWS    SET # 6
1. WINDOW TYPE: INDUSTRIAL SASH
2. NUMBER OF WINDOWS: 2
3. LOWER RIGHT CORNER:(181751  .1066  )
4. UPPER LEFT CORNER: (183784  .2266  )
5. WINDOW SEPARATION :4340  mm
WINDOW GLAZING
1. GLAZING MATERIAL: GLASS
2. NUMBER OF GLAZINGS: 1
WINDOW FRAME
1. FRAME MATERIAL: ALUMINUM
2. THERMAL BREAK:  NONE
3. WEATHERSTRIP: FOAM PLASTIC
OVERHANG: Dim 'H': 0    mm
          Dim 'L': 0    mm
 FINS: Dim 'C': 0    mm
       Dim 'D': 0    mm
       Dim 'E': 0    mm

        WINDOWS    SET # 7
1. WINDOW TYPE: INDUSTRIAL SASH
2. NUMBER OF WINDOWS: 1
3. LOWER RIGHT CORNER:(221438  .2379  )
4. UPPER LEFT CORNER: (222638  .3687  )
WINDOW GLAZING
1. GLAZING MATERIAL: GLASS
2. NUMBER OF GLAZINGS: 1
WINDOW FRAME
1. FRAME MATERIAL: ALUMINUM
2. THERMAL BREAK:  NONE
3. WEATHERSTRIP: FOAM PLASTIC
OVERHANG: Dim 'H': 0    mm
          Dim 'L': 0    mm
 FINS: Dim 'C': 0    mm
       Dim 'D': 0    mm
       Dim 'E': 0    mm

        DOORS      SET # 1
1. DOOR TYPE: SWINGING (MAN)
2. NUMBER OF DOORS: 3
3. LOWER RIGHT CORNER: (30286   .0     )
4. UPPER LEFT CORNER: (31302   .2288  )
5. DISTANCE BETWEEN CENTRES: 22186mm
6. DOOR MATERIAL: STEEL
7. RSI VALUE: .4
(UNINSULATED)
8. OPERATION MECHANISM: MANUAL
GLAZINGS (1)
GLAZING MATERIAL: GLASS
HEIGHT: 1000 mm
WIDTH: 800  mm
```

```
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: YES

         DOORS      SET # 2
1. DOOR TYPE: SECTIONAL OVERHEAD (S)
2. NUMBER OF DOORS: 4
3. LOWER RIGHT CORNER: (48083   ,0      )
4. UPPER LEFT CORNER: (51893   ,4117   )
5. DISTANCE BETWEEN CENTRES: 7502 mm
6. DOOR MATERIAL: WOOD
7. RSI VALUE: .35
(UNINSULATED)
8. OPERATION MECHANISM: ELECTRIC
GLAZINGS (1)
GLAZING MATERIAL: PLASTIC
HEIGHT: 3100 mm
WIDTH: 300  mm
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: YES
DOCK LEVELLER: NO
SEAL AT DOCK LEVELLER: NO
TRUCK SEALS: NO
AIR CURTAIN: NO
THE SHIPPING AREA IS NOT ISOLATED
HOURS OPEN PER DAY: 0    hrs

         DOORS      SET # 3
1. DOOR TYPE: SWINGING (MAN)
2. NUMBER OF DOORS: 1
3. LOWER RIGHT CORNER: (107890  ,0      )
4. UPPER LEFT CORNER: (108906  ,2288   )
5. DISTANCE BETWEEN CENTRES:  N/A
6. DOOR MATERIAL: STEEL
7. RSI VALUE: 0.4
(UNINSULATED)
8. OPERATION MECHANISM: MANUAL
GLAZINGS (1)
GLAZING MATERIAL: GLASS
HEIGHT: 1000 mm
WIDTH: 800  mm
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: YES

         DOORS      SET # 4
1. DOOR TYPE: SECTIONAL OVERHEAD (S)
2. NUMBER OF DOORS: 1
3. LOWER RIGHT CORNER: (109922  ,0      )
4. UPPER LEFT CORNER: (113683  ,4118   )
5. DISTANCE BETWEEN CENTRES:  N/A
6. DOOR MATERIAL: WOOD
```

```
7. RSI VALUE: .35
(UNINSULATED)
8. OPERATION MECHANISM: ELECTRIC
GLAZINGS (1)
GLAZING MATERIAL: GLASS
HEIGHT: 3100 mm
WIDTH: 300  mm
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: YES
DOCK LEVELLER: NO
SEAL AT DOCK LEVELLER: NO
TRUCK SEALS: NO
AIR CURTAIN: NO
THE SHIPPING AREA IS NOT ISOLATED
HOURS OPEN PER DAY: .5   hrs

         DOORS      SET # 5
1. DOOR TYPE: SWINGING (MAN)
2. NUMBER OF DOORS: 1
3. LOWER RIGHT CORNER: (132675  ,0      )
4. UPPER LEFT CORNER: (133691  ,2288  )
5. DISTANCE BETWEEN CENTRES:  N/A
6. DOOR MATERIAL: STEEL
7. RSI VALUE: .4
(UNINSULATED)
8. OPERATION MECHANISM: MANUAL
GLAZINGS (0)
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: NO

         DOORS      SET # 6
1. DOOR TYPE: SWINGING (MAN)
2. NUMBER OF DOORS: 2
3. LOWER RIGHT CORNER: (140644  ,0      )
4. UPPER LEFT CORNER: (142676  .2288  )
5. DISTANCE BETWEEN CENTRES: 1016 mm
6. DOOR MATERIAL: STEEL
7. RSI VALUE: .4
(UNINSULATED)
8. OPERATION MECHANISM: MANUAL
GLAZINGS (0)
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: NO

         DOORS      SET # 7
1. DOOR TYPE: SWINGING (MAN)
2. NUMBER OF DOORS: 2
3. LOWER RIGHT CORNER: (175956  ,0      )
4. UPPER LEFT CORNER: (176973  ,2288  )
5. DISTANCE BETWEEN CENTRES: 9425 mm
```

```
6. DOOR MATERIAL: STEEL
7. RSI VALUE: .4
(UNINSULATED)
8. OPERATION MECHANISM: MANUAL
GLAZINGS (1)
GLAZING MATERIAL: GLASS
HEIGHT: 1000 mm
WIDTH: 800  mm
 DOOR FRAME
FRAME MATERIAL: ALUMINUM
WEATHER STRIP: YES

        DOORS      SET # 8
1. DOOR TYPE: SECTIONAL OVERHEAD (S)
2. NUMBER OF DOORS: 3
3. LOWER RIGHT CORNER: (198066  ,0      )
4. UPPER LEFT CORNER: (201876  ,4117   )
5. DISTANCE BETWEEN CENTRES: 7672 mm
6. DOOR MATERIAL: WOOD
7. RSI VALUE: .35
(UNINSULATED)
8. OPERATION MECHANISM: ELECTRIC
GLAZINGS (1)
GLAZING MATERIAL: GLASS
HEIGHT: 3100 mm
WIDTH: 300  mm
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: YES
DOCK LEVELLER: NO
SEAL AT DOCK LEVELLER: NO
TRUCK SEALS: NO
AIR CURTAIN: NO
THE SHIPPING AREA IS NOT ISOLATED
HOURS OPEN PER DAY: 2.0  hrs

        DOORS      SET # 9
1. DOOR TYPE: SWINGING (MAN)
2. NUMBER OF DOORS: 1
3. LOWER RIGHT CORNER: (224507  ,0      )
4. UPPER LEFT CORNER: (225523  ,2288   )
5. DISTANCE BETWEEN CENTRES:  N/A
6. DOOR MATERIAL: STEEL
7. RSI VALUE: .4
(UNINSULATED)
8. OPERATION MECHANISM: MANUAL
GLAZINGS (1)
GLAZING MATERIAL: GLASS
HEIGHT: 1000 mm
WIDTH: 800  mm
 DOOR FRAME
FRAME MATERIAL: STEEL
WEATHER STRIP: YES
```

```
  BUILDING ROOFS     1st Roof
TYPE: B.U.R.
:RSI=.88
LOWER RIGHT CORNER: (45725    ,60965     )
UPPER LEFT CORNER: (0        ,0          )
Layer            Element
 1st  BALLAST/FINISH:  18   mm
      TYPE: STONE
      COLOUR: LIGHT
 2nd  MEMBRANE:  10   mm
      MATERIAL: FELTS AND ASPHALT
      DRAINAGE: CENTRE
 3rd  INSULATION:  38   mm
      MATERIAL: RIGID FIBERGLASS
      VENTS: NONE
 4th  DECK:  38   mm
      MATERIAL: STEEL
      FIRE PROTECTION: YES
 5th  STRUCTURE:  450  mm
      MATERIAL: STEEL
      SPANDRELS: O.W.S.J.

  BUILDING ROOFS     2nd Roof
TYPE: B.U.R.
:RSI=.88
LOWER RIGHT CORNER: (27074    .68216     )
UPPER LEFT CORNER: (19374    ,61715     )
Layer            Element
 1st  BALLAST/FINISH:  18   mm
      TYPE: STONE
      COLOUR: LIGHT
 2nd  MEMBRANE:  10   mm
      MATERIAL: FELTS AND ASPHALT
      DRAINAGE: PERIMETER
 3rd  INSULATION:  38   mm
      MATERIAL: RIGID FIBERGLASS
      VENTS: NONE
 4th  DECK:  38   mm
      MATERIAL: STEEL
      FIRE PROTECTION: NONE
 5th  STRUCTURE:  300  mm
      MATERIAL: STEEL
      SPANDRELS: O.W.S.J.

  SERVICE SYSTEMS:  Space Conditioning   Area # 1
AREA SERVED: OFFICE
PURPOSE(S): HEATING, COOLING, FILTERING, DEHUMIDIFICATION, FRESH AIR
SYSTEM TYPE :CENTRAL (IN BUILDING) - BOILER WITH FAN-COIL UNITS
EQUIPMENT INFORMATION
     NUMBER OF UNITS: 1
     TYPE:  INDIRECT FIRED
     MODEL NUMBER :  TRANE 8TH
     SERIAL NUMBER : CLIMATE CHANGER
     MOTOR RATINGS :  2     h.p.
     MAKE UP AIR SUPPLY? : YES
FUEL TYPE : NATURAL GAS
     RATED INPUT :  NA        BTU/hr
     RATED OUTPUT :  NA        BTU/hr
DISTRIBUTION MEDIUM: AIR
DISTRIBUTION SYSTEM: DUCTWORK
  SYSTEM INSULATION: NONE
CONTROL TYPE: CENTRAL
SET BACK: AUTOMATIC
SET POINTS:     Deg C     # hrs/wk
                 20         40
                 18         80
                 18         48

  SERVICE SYSTEMS:  Space Conditioning   Area # 2
AREA SERVED: OFFICE
PURPOSE(S): HEATING, FILTERING, FRESH AIR
SYSTEM TYPE :CENTRAL (IN BUILDING) - FURNACE IN BUILDING
EQUIPMENT INFORMATION
     NUMBER OF UNITS: 1
     TYPE:  INDIRECT FIRED
     MODEL NUMBER :  REZNOR FURN.
     SERIAL NUMBER : NA
     MOTOR RATINGS :  .5    h.p.
     MAKE UP AIR SUPPLY? : YES
FUEL TYPE : NATURAL GAS
     RATED INPUT :  NA        BTU/hr
     RATED OUTPUT :  NA        BTU/hr
DISTRIBUTION MEDIUM: AIR
DISTRIBUTION SYSTEM: DUCTWORK
  SYSTEM INSULATION: NONE
CONTROL TYPE: CENTRAL
SET BACK: MANUAL
SET POINTS:     Deg C     # hrs/wk
                 20         40
                 20         80
                 20         48

  SERVICE SYSTEMS:  Space Conditioning   Area # 3
AREA SERVED: WAREHOUSE
PURPOSE(S): HEATING
SYSTEM TYPE :DISTRIBUTED - UNIT HEATERS
EQUIPMENT INFORMATION
     NUMBER OF UNITS: 9
     TYPE:  INDIRECT FIRED
     MODEL NUMBER :  TRANE UNIT HTR.
     SERIAL NUMBER : CPA 125A
     MOTOR RATINGS :  .125  h.p.
     MAKE UP AIR SUPPLY? : NO
FUEL TYPE : NATURAL GAS
     RATED INPUT :  NA        BTU/hr
```

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    RATED OUTPUT :  NA        BTU/hr
DISTRIBUTION MEDIUM: AIR
DISTRIBUTION SYSTEM: NONE
  SYSTEM INSULATION: NONE
CONTROL TYPE: DISTRIBUTED
SET BACK: AUTOMATIC
SET POINTS:     Deg C     # hrs/wk
                 18        40
                 14        80
                 14        48

  SERVICE SYSTEMS:  Exhaust and Make-up Air   Area # 1
AREA SERVED: SPECIFIC ROOM
PURPOSE(S): EXHAUST
EQUIPMENT INFORMATION
     NUMBER OF UNITS: 1
     MODEL NUMBER :  WALL MOUNTED
     SERIAL NUMBER : FAN
     MOTOR RATINGS :  .1    h.p.
MAKE-UP AIR SUPPLY UNIT? : NO
  DISTRIBUTION DUCTWORK? : NO
CONTROLS: MANUAL SWITCHING
HEAT RECOVERY SYSTEM? : NO

  SERVICE SYSTEMS:  Exhaust and Make-up Air   Area # 2
AREA SERVED: SPECIFIC ROOM
PURPOSE(S): EXHAUST
EQUIPMENT INFORMATION
     NUMBER OF UNITS: 1
     MODEL NUMBER :  SHELDON ROOFTOP
     SERIAL NUMBER : EXHAUST FAN
     MOTOR RATINGS :  .5    h.p.
MAKE-UP AIR SUPPLY UNIT? : NO
  DISTRIBUTION DUCTWORK? : NO
CONTROLS: MANUAL SWITCHING
HEAT RECOVERY SYSTEM? : NO

  SERVICE SYSTEMS:  Lighting    Area # 1
AREA SERVED: ENTIRE BUILDING
BULB TYPE: FLOURESCENT
BULB WATTAGE: 40     watts
BULB VOLTAGE: 120   volts
FIXTURE LOCATION: AT CEILING
DIFFUSER: NONE
CONTROL TYPE: MANUAL
NATURAL LIGHTING IS SIGNIFICANT
NATURAL LIGHTING SOURCE: WINDOWS

  SERVICE SYSTEMS: Natural Gas Consumption Record
PURPOSE(S): SPACE HEATING, DOMESTIC H2O HEATING
ACCOUNT NUMBER: NA
   READING DATE   COST   CONSUMPTION
      MMDDYY       ($)      (cu. m.)
     052280          377         3716
     062080          66          558
     072380          51          425
     082180          46          371
     092280          60          510
     102380          400         3903
     112080          657         6451
     122380          1758        16083
     012181          1706        14299
     021881          1559        12869
     031881          1169        9612
     042381          733         6259
     052081          347         2762
     062481          162         1286
     072281          45          309
     081981          46          312
     092381          91          654
     102181          423         3121
     112581          1074        7859
     122381          1409        10394
     012082          2439        18162
     022482          1846        13574
     032482          1734        11555
     042182          1228        7933
     052682          387         2402
     062482          94          524
     072082          49          252
     082582          61          329
     092382          171         974
     102082          266         1569

  SERVICE SYSTEMS: Fuel Oil Consumption Record
PURPOSE(S):
ACCOUNT NUMBER: NA
   READING DATE    COST    CONSUMPTION
      MMDDYY        ($)     (litres)


  SERVICE SYSTEMS: Electricity Consumption Record
PURPOSE(S): , MOTORS, LIGHTING, PROCESS MACHINES, EXHAUST FANS
ACCOUNT NUMBER: NA
   READING DATE    COST    CONSUMPTION
      MMDDYY        ($)     (kW hrs)

     050080          341         9640
     060080          479         15520
     070080          404         12240
     080080          466         14960
     090080          436         13640
     100080          444         14000
     110080          439         13760
     120080          515         17120
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010081        628       22120
020081        622       19440
030081        538       16120
040081        512       15080
050081        435       12000
060981        417       11320
071581        508       14920
081181        399       10600
091181        435       12000
101581        394       10400
111181        456       12840
120081        480       13800
010082        736       23960
021582        688       19680
031582        531       14080
041582        600       16560
051382        459       11520
061582        508       13280
071482        456       11400
081382        496       12840
091382        437       10720
101382        521       13720
111182        491       12640
```